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Science News x

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THE PLACE OF RESEARCH IN THE COLLEGE[1]

IT is a common idea, all too common, that research should be left to the universities, research institutes and the great corporations.

"The primary function of the college is to teach!" is a statement often made with misleading emphasis. All good educators agree on the dominant position of teaching in the college, but many know that teaching attains its highest degree of efficiency only when the research attitude of mind is developed in the student and a research atmosphere fostered in the institution. I know teachers whose scholarship and teaching have been vitalized by enthusiasm over their own research problems. The limited time spent on these problems paid rich dividends not measured in dollars alone.

The general misunderstanding of the true nature and the methods of research is appalling. The typical research professor is not, as so many fear, a retiring and very peculiar genius irritated by teaching duties and interested only in his own selfish problems. Instead of neglecting teaching the ideal teacher brings to his lectures the freshness of originality and gives to his words the ring of authority. There are, of course, brilliant men who have no place on a college faculty, but there are also many, ever so many, priding themselves on their exclusive attention to teaching, whose words are as dry dust in the mouth.

Pure research is sometimes damned with the triumphant question, "Of what use is it?" Let J. J. Carty, of the American Telephone and Telegraph Company, give answer. "The pure scientist is the advance guard of civilization." Herbert Hoover adds, "Our whole banking community does not do the public service in a day that Faraday's discoveries do us daily." In speaking of the chemical research on coal-tar that has given the world a thousand beautiful dyes such as were never known before, indispensable medicines, liquid fuels, wood preservatives, high explosives and many other remarkable products, H. H. Gray pays a merited tribute to originality. "After all, only mind can transform the pence of coal-tar into the sovereigns of fine chemicals. Capital can draw the dividends and labor can plume itself on its indispensability, but it is mind which performs the miracle."

[1] Address given at Wittenberg College on the occasion of the dedication of the Laboratory for Chemistry.

It is idle and unfair to quote a few examples of silly and futile research as proof that the whole business would be a waste of college time and money. Sane supervision will protect it from abuse.

There is far too much stress on the informational side of college teaching. We boast that we train the student to think and indignantly deny that we are fact-stuffers, yet most college faculties withhold from the student the most effective method of thought ever developed, the scientific method, the research method. The worst of it is that some of our leaders pride themselves on thus cheating the undergraduate out of his intellectual rights and privileges. The faulty habits of thought that should be trained out of college students are summarized in a forceful way by Fairchild (pamphlet issued by the Character Education Institution of Washington).

INTELLECTUAL IMMORALITIES

(1) Carelessness in observations.

(2) Inaccuracy in determining units to be counted in statistical research.

(3) Slovenliness in logic, fantastic explanations.

(4) Generalizing beyond one's data.

(5) Confusing opinions with knowledge.

(6) Contentment with "discussion."

(7) Egoism allowed to crowd one to the invention of "new" theories for personal distinction.

(8) Inventing interesting theories for the sake of selling them in books, articles, lectures and conversation.

(9) Formulating an hypothesis on weak bases of facts, and then becoming blind to facts in opposition.

(10) Emotionalism during research, "I believe" instead of "I have proved."

(11) Opposition to a theory merely because of ignorance and stupidity, "I can not see how."

(12) Rushing into print with a report of research work that justifies no conclusions.

(13) Cowardice in supporting a verified generalization because it is unpopular and conflicts with selfish interests.

(14) Impatience, unwillingness to proceed step by step through a research.

(15) Indulgence in dense verbiage for the sake of appearing superlearned.

(16) Poularizing tentative generalization for the sake of personal publicity.

(17) Resort to the authorities, or to sarcasm and ridicule, against data, arguments and verifications.

"Verification" seems to have been too little appreciated in college circles as a factor essential to all research supposed to be on the scientific level. We must do more than indulge in "views, theories and endless discussions."

An indignant believer in the scientific method of thinking writes me, "My cousin is the wife of a great scientist, but she has lost her senses over the modern fake imitations of psychology and writes articles without any conscience as to verification of her generalizations; the spirit of the fantastic thinker is in her rather than that of the scientist."

Ira Remsen believed in the ethical virtues of research. The essential honesty of a scientist with his problem appealed to Remsen as making for superior character. The late Charles D. Walcott, former secretary of the Smithsonian Institution, went further and insisted that a good research man ought to make a good Christian and a good Christian ought to make a good research man because both are in search of truth.

Herbert Hoover well says, "If we would command the advance of our material, and to a considerable degree, of our spiritual life, we must maintain the earnest and organized search for truth. We could well put such an appeal wholly upon moral and spiritual grounds; the unfolding of beauty, the aspiration to knowledge, the ever-widening penetration into the unknown, the discovery of truth, and finally, as Huxley says, 'the inculcation of veracity of thought.'"

If we hope to inspire the college youth we must make him feel that he is drinking from a fresh spring of knowledge rather than from a stagnant pool. As one keen student remarked, "I notice that the teaching is better when there is some research going on around the corner."

Oberlin's great librarian, Azariah Root, in the last year of a scholarly life, announced to a college committee, "What Oberlin must do is to spend more money on research and to encourage it in every way in order to keep our faculty from growing stale." Oberlin is probably doing as much in research as any pure college, but there is much more to do. An inspired faculty develops an inspired student body.

"Research by stealth" is an unpleasant phrase used to describe the situation in some colleges where the professor is expected to spend his entire time in routine teaching. A recent questionnaire disclosed the fact that only a very limited number of college presidents are willing to encourage research by financial aid for productive work. Some others are willing to have national honor brought to the college by research publications of its faculty if no expense is involved. This short-sighted policy cheats the students by driving away the ambitious, productive scholars of the faculty.

Without a staff of productive men how shall the college meet the challenge of the gifted students? Informational teaching is not adequate, but sound instruction in the research method of approach to all problems will stimulate the gifted student to his best. Even a freshman will ignite from the right sort of

spark, although he will not actually engage in research. Instead of describing achievements to him in the final form the instructor can lead him in fancy, step by step, through all the difficulties preliminary to great discoveries, disclose the original plans and hopes, and arrive at the climax of successful achievement with dramatic force. It is more than the historical method, it is the living, breathing, thrilling method of teaching.

In actual practice undergraduates respond eagerly when asked to walk occasionally in the footsteps of the great masters of the past. Many of them get from the experience "a sense of unlimited possibilities, of adventure and of exultant hope." They can be thrilled with the conception of research as service to humanity in conquering yellow fever, in making the surgeon's work safe with antiseptics and merciful with anesthetics, in averting a predicted world wheat famine, in making every man your neighbor by marvelous improvements in communication and transportation, and by reducing the working day of fifteen hours, common a century ago, to the modern day of eight hours with its increased possibilities for health, comfort, culture and the pursuit of happiness. To prove to the youthful mind that the pure research of Faraday, Henry and others made possible the electrical industry which in the United States now multiplies the man-power of our population is to give a vivid impression of service. Slaves rushing along a wire at the touch of a button to run our errands, lift us to the lofty floors of our office buildings, run our washing machines, sweep our floors and save us from drudgery even as a thousand captives once slaved for a petty king of the long ago!

Beyond the question of inspiring the undergraduate and training his mind in the mastery of the varied problems of life is the moral obligation on the college to acknowledge its debt to the past by adding something new to the sum total of knowledge. Is it right for a great institution of learning to hand out facts other faculties have gathered without sharing in production? Carlyle exclaimed, "Produce, if it be but the pitifullest infinitesimal fraction of a product, in God's name produce."

The sciences, it must be admitted, have done more than the non-sciences in recognizing this obligation. Professor John R. Commons, of the University of Wisconsin, has extended this statement to include the universities, "To acquire knowledge—the existing knowledge—is the retail store method, the hand-me-down method. The research method is just opposite; it is the discovery method. We do not acquire knowledge, we discover knowledge, using the dig-it-up method. In economics, in sociology, in philosophy, in all those sciences which have to do with the great laboratory of human life throughout the community, we have not yet learned the laboratory method, the dig-it-up method."

The American Historical Association, in a recent report, admits that fewer than one fourth of the holders of the Ph.D. degree in history are productive scholars. A quotation from this report follows: "Presidents, especially of the smaller colleges, insist on having Ph.D.'s on their faculties, not because they expect or wish them to be productive scholars, but largely for advertising purposes. The large universities are thus crowded with mediocre graduate students, many of whom can not be taught the technic of research except with great difficulty. It is still more difficult, and often impossible, to inspire them with a passion for research. One important reason for lack of production is a widespread belief that research does not pay. It is alleged that many who are productive fail to gain the reward they might reasonably expect; that presidents of colleges and universities give lip-service to research, but do not take it into consideration to any great extent in making promotions or increases in salary; that, therefore, Ph.D.'s seek to advance by teaching, wire-pulling and 'social stunts.'"

Bertrand Russell and the Bishop of Ripon are suggesting that if scientists desist from discovery for ten years the rest of the world might catch up and adjust itself to a condition of tranquility. This is an admission of weakness, not an acceptance of a challenge. Evidently the eight hundred thousand college students of this country need an insight into the scientific method of collecting facts by many accurate, unbiased observations, of classifying and comparing facts, of explaining the facts with a theory or generalization, of rigidly and honestly testing the theory and of using the tested theory to predict future behavior.

There are, of course, difficulties in making research an integral part of college teaching. Many men now on college faculties, though trained to research, in the struggle for the Ph.D. degree have allowed this acquired talent to atrophy. Now they shrink from any belated demand for productivity. It is difficult to blame them. Rather let us blame the college for overloading such men with mere routine teaching and for a general failure to recognize, encourage and reward a proper amount of productivity. The cost is a veritable lion in the path, but must it forever stand in the path to the highest excellence?

Adequate reward for research will doubtless bring on its attendant evils. Publications of an inferior order will be cited for promotion, but it is easy to get the judgment of leaders in a given field as to the quality of original work. Time will, in a few in-

stances, be frittered away on silly struggles to be original, but why not, in the future, deny to such men the opportunities to continue this waste? "To him that hath (the Divine spark) shall be given, and to him that hath not shall be taken away."

The Division of Educational Relations of the National Research Council suggests:

WAYS TO AID RESEARCH IN COLLEGES

Give research a place in faculty meetings on a parity with teaching problems.

Give research, as a matter of course, recognition in the budget of each department of study; grants for apparatus, literature, research assistants, etc.

Have special research fund for special grants, this to be administered by the research committee. Emphasize dignity and importance of this committee.

Give stenographic and clerical assistance to faculty members to conserve their time and energy for teaching and research.

Cut down hours of teaching.

Large faculties, small classes.

Leaves of absence, on salary, for intensive study.

Consultation trips by college men to the research centers for advice and conference and reading.

Exchange of teachers between universities and colleges (and perhaps exchange of research men between industry and the colleges).

Assistance toward expense of attending professional society meetings.

Research as well as teaching success recognized as a basis for promotion.

Special professorships for those markedly successful in both research and teaching, with added time and assistance for research, and additional salary.

Appointment of occasional research associates giving full time to research.

Encouragement of research for the M.A. degree; also special stipends for M.A. students who shall assist professors in their research.

Research scholarships for outgoing seniors and for recent graduates to study in research institutions.

Develop the library for assistance to research as well as to teaching.

The appointment or election of a standing research committee on the college faculty is vitally important.

FUNCTIONS OF A COLLEGE RESEARCH COMMITTEE

Promote appreciation of importance of research on the part of all members of the college community, including trustees, administrative officers, faculty students and donors.

Survey and list the researches in progress in the institution.

List the more important researches published in the past from the college.

Gather and classify information in regard to the entrance of graduates upon research, and list the ablest men among the graduates of the college.

Learn, classify and list the assistance needed for: (a) researches in progress, (b) researches it is desired to undertake. Assist in plans for securing such aid.

Publish these items for circulation in the college community.

Publish an annual report for circulation in the college.

Assist in securing cooperation between faculty members in research.

Study and suggest possible correlations between researches under way in the college.

Consider publication of research results—perhaps advisable, especially for studies of local environment. Publication assistance is especially needed in the so-called "humanities." Avoid encouraging publication of unworthy papers.

Secure a liberal research fund, grants from which shall be administered by the research committee.

Exchange with local committees in other colleges information as to methods and success in promotion of research.

Arrange for presentation to the students, by men from the several departments and from outside the college, of the life devoted to research, in the several major fields. This is important in securing recruits for the life of research.

Encourage departmental clubs which shall report and discuss research and newer phases of progress in knowledge, discussing also the men through whose research mankind have made great advance.

Encourage work by semi-research methods in the curriculum, putting some of this work as early as the sophomore year.

Encourage establishment of societies and fraternities which reward research ability.

Present research to community by lectures and exhibits.

Urge value of administrative assistants to relieve faculty members of detailed committee work.

Ten years ago Oberlin College, at the request of the National Research Council, elected a science research committee and made it a standing committee of the faculty with all the privileges thus implied. The small original committee set a high standard of election. Every man on a science faculty was asked to submit a list of his research publications exclusive of his doctor's thesis. If his independent work published in journals of good standing measured up in quality and quantity he was recommended for election, which always followed as a faculty endorsement. It is now considered an honor to be a member of this committee. At occasional dinners the members discuss the situation and plan for the future.

In addition to this group of scientists a "Committee on Productive Scholarship" is now being formed in somewhat similar fashion. However, the qualifications include authorship of books (other than mere compilations) and musical compositions of merit as well as scientific research. Obviously productive

work in the entire faculty will be encouraged and made prominent.

All this is eminently worth while if we agree with President Angell, of Yale, who urges that "Individual initiative, resourcefulness, ingenuity, imagination, vision, must be kept at a high pitch all along the line."

HARRY N. HOLMES

OBERLIN COLLEGE

EARLY PSYCHOLOGICAL LABORATORIES[1]

LABORATORIES for research and teaching in the sciences are of comparatively recent origin. They may be regarded as part of the industrial revolution, for there is a close parallel in causes and effects between the development of the factory system and of scientific laboratories. The industrial revolution began with the exploitation by machinery of coal and iron in England; it may perhaps be dated from the use of the steam engine of Watts in the coal mines of Cornwall about a hundred and fifty years ago.

The laboratory had its origin fifty years later in Germany as part of the scientific renaissance following the Napoleonic wars. The University of Berlin was founded by Wilhelm von Humboldt and Frederick William III in 1810. The first laboratory of chemistry was opened by Justus von Liebig at Giessen in 1824. This was followed by similar laboratories at Göttingen under Wöhler in 1836, at Marburg under Bunsen in 1840, and at Leipzig under Erdmann in 1843. The first English laboratory was the College of Chemistry, now part of the Imperial College of Science and Technology of the University of London, which was opened in 1845 by von Hoffmann, brought from Germany by Prince Albert. Benjamin Silliman founded at Yale University the first American laboratory for the teaching of chemistry.

Prior to the industrial revolution the artisan worked at home, sometimes with 'prentices, who were often his children. The factories, the mines and the systems of transportation, with their machinery, their skilled overseers and division of labor, their owners and entrepreneurs, their exchange of commodities and ideas, created a remarkable economy in production, so that now each individual may perhaps work half as long and consume twice as much wealth as formerly. But there are serious drawbacks in the lack of freedom and initiative of the workman, in the loss of joy in creative work. The situation in the laboratory is similar. A professor may have many associates, assistants and students; expensive apparatus and extensive libraries may be installed; division of labor in each laboratory and among laboratories can be planned; there may be exchange of ideas and of information on the progress of research; students are taught in large groups. Production is greatly increased, perhaps quadrupled, as in the industrial system. But the scientific man is subject to administrative controls; he is no longer free; he must compromise with others and teach all sorts of students. The system is useful for the production of a large mass of routine work; it may not be favorable to creative genius.

Anatomy has been called the mother of the sciences; dissecting rooms go back to the medieval universities of Italy. Observatories, museums, botanical gardens, academies of science and university schools, where research was undertaken and in which students and assistants were taught and trained, preceded organized laboratories. Chemistry is the gold transmuted through alchemy; we have all seen on the stage the laboratory of Faust. Christian fathers say that when "the sons of God saw the daughters of men, that they were fair and they took them wives," as told in the sixth chapter of Genesis, these fallen angels taught the fair daughters of men the arts of astrology and alchemy. Scientific men who do not care for special creations may assume that there has been a gradual development from the time of the first experiment by an anthropoid ape, or it may be by a paramecium or an electron. If, however, we want an official beginning for the first scientific laboratory, it will be the laboratory of chemistry at Giessen, the hundredth anniversary of whose foundation was celebrated three years ago.

Chemical laboratories were followed by laboratories of physics and biology. I worked in the first American biological laboratory in its early days. It was established at the Johns Hopkins University by Newell Martin, a student of Huxley, who at the Royal College of Science had founded the first laboratory of biology. From the laboratories of Martin and Brooks at the Johns Hopkins have proceeded many of our most eminent biological workers. The Johns Hopkins also led in the establishment under Welch, Mall, Abel and Howell of laboratories in the medical sciences. But there is obviously no sharp line of demarcation between the modern laboratory and earlier groups of workers, such as the great school of zoology conducted by Agassiz at Harvard.

The first laboratory of psychology was established by Wilhelm Wundt. In an article on the Leipzig laboratory, published in *Mind* in 1888 and submitted to Professor Wundt, I give the date as 1879. The fiftieth anniversary of the founding of the labora-

[1] Address on the occasion of the inauguration of the Psychological Laboratory of Wittenberg College, Springfield, Ohio, October 21, 1927.

tory was, however, celebrated at Leipzig in 1926. Wundt published his "Grundzüge der physiologischen Psychologie" in 1874 and was called from Zürich to a chair of philosophy at Leipzig in 1875. The *Psychologische Institut* there was a gradual development. Wundt writes in his autobiography "Erlebtes und Erkanntes," published in 1920, that Kraepelin, Lehmann and I were his three earliest "Arbeitsgenossen" who remained faithful to psychology and that we worked with him at a time when the institute was his private undertaking and lacked official recognition on the part of the university. The first research published from the Leipzig laboratory was apparently a doctor's dissertation by Dr. Max Friedrich carried out during the winter semester of 1879–80.

Wundt writes in the preface to the "Physiologische Psychologie" that it undertakes "ein neues Gebiet der Wissenschaft abzugrenzen," but he was partly anticipated by Hermann Lotze, whose "Medizinische Psychologie" was published in 1852. Both Lotze and Wundt had a medical education and were professors of philosophy. Their books are landmarks in the history of our science. It was my privilege to hear the last course of lectures on psychology by Lotze given at Göttingen in the winter semester of 1880–81. In accordance with the custom of that university Lotze dictated summaries which could be written down verbatim even by one who had small psychology and less German. The "Dictata" of that year were published and have been translated into English. In the spring of 1881 Lotze, then 74 years of age, migrated to Berlin and died, according to Göttingen opinion, of homesickness.

Herbart, whom Lotze succeeded at Göttingen, had tried to give a mathematical formulation to psychology as Spinoza had to philosophy. He published the first edition of his "Einleitung in die Philosophie" in 1813. There followed Drobitsch, Lindner, Benecke, Volkmar and other German psychologists. In England we have the notable development of association and analytic psychology from Locke through Berkeley, Hume, the Mills and Bain to Ward. The first edition of Carpenter's "Mental Physiology," to-day a useful and readable book, was published in 1874, the same year as Wundt's "Grundzüge." In England and in France there were numerous workers in the fields of physiological and pathological psychology.

The most important developments for laboratory psychology were through the great German physiologists and physicists, most of all Helmholtz, who passed from physiology to physics. His "Physiologische Optik," recently translated under the editorship of Professor Southall and published as an act of piety by the Optical Society, and his "Tonempfindingen," of which there is an earlier translation, are classics in the history of science. E. H. Weber became professor of anatomy at Leipzig in 1818 at the age of twenty-three, being later transferred to physiology. The law that bears his name was stated in his "Annotationes," published from 1834 to 1851. Fechner was appointed professor of physics at the same university in 1834; his "Zendavesta" was published in 1851, his "Elemente der Psychophysik" in 1860. When I was a student at Leipzig he was over eighty-five years old and blind from experiments on vision, a charming man, intensely interested in his psychophysical experiments, though chiefly in philosophical interpretations.

The middle fifty years of the last century were the golden age of the German university and of science, its *Wunderkind*. It is marvelous what was accomplished then and there. Thus in the little corner of the field of science concerned with the psychology of the sense of vision there worked, in addition to Helmholtz and Fechner, a notable company, including Aubert, Brücke, du Bois-Reymond, Donders (in Holland), Exner, Fraunhofer, Fick, von Graefe (who examined my eyes when I was a child of eight), Hering, Hermann, von Kries, Listing, Johann Mueller, Nagel, Purkinje, Vierordt, the Webers and many more. There is no such group in the world to-day working on vision or in any other part of experimental psychology. At that time the investigation of the other senses, of movement, of the time of reaction and much else was pursued probably to greater effect than in all the innumerable laboratories of to-day.

The fields so fertile in the nineteenth century were of course cleared at an earlier time. Experiments on vision go back to Kepler, Huygens and Newton. Weber's law was anticipated by Bouguer and Lambert; Fechner's law by Bernouilli and Laplace; the personal equation by the astronomers. Observations on after-images were made not only by Goethe, the elder Darwin, Buffon and Newton among others, but also by Augustine and Aristotle. Very curiously the problems of psychological measurement were clearly stated by the poet Shelley, who more than a hundred years ago wrote: "A scale might be formed, graduated according to the degrees of a combined scale of intensity, duration, connexion, periods of recurrence, and utility, which would be the standard, according to which all ideas might be measured."

When I came across this passage in Shelley it seemed almost incredible that he of all men should have written it, as indeed it is that the most unearthly of poets should have been the son of a country squire. But England has always given birth to great men in families and as sports. It has been said that Graham Bell—he too was British—could not have invented the telephone if he had been a physicist, for he would have known that it was impossible; so it may be said

that Francis Galton could not have accomplished his great work toward founding modern psychology if he had been a psychologist, for he would have known that it was not psychology. Galton, like Darwin, his cousin, had no university position and no laboratory. He published his "Hereditary Genius" in 1869, his "Inquiries into Human Faculty" in 1883.

With intermissions I was a student at Leipzig under Wundt from 1881 to 1886, serving during the last year as laboratory assistant in psychology, the first to be appointed there or anywhere. Wundt had a higher opinion, doubtless with good reason, of American enterprise than of American scholarship. In his reminiscences he writes that with "bekannter Amerikanischer Entschlossenheit" I approached him and declared: "Herr Professor, you need an assistant and I shall be your assistant." He was the most kindly of men and was much worried lest I should not pass my doctorate examination in physics under Hankel and in zoology under Leuckhart, but these distinguished professors also fortunately made due allowance for a child of the wilderness. Wundt's combined courtesy and remoteness from the modern world may be illustrated by an incident. At that time women were seldom admitted to university lectures, but at my request he gave permission to an American of fine intelligence to attend his course on psychology, which was frequented by two or three hundred students, among them the most stupid in the university, for all theological students were required to attend. One day he said: "I am sorry that I let Miss X attend my lectures; it embarrasses me; I feel that I ought to speak in a way that a woman can understand."

When I showed Wundt an outline of the work that I proposed for a doctor's thesis on the reaction-time, including complicated responses and a study of individual differences his comment was: "ganz Amerikanisch." As a matter of fact I did the work in my own rooms and with my own apparatus. At that time students were expected to work in the laboratory on a subject assigned by the professor, during certain definite hours in the afternoon and with the apparatus supplied, which had to be put away neatly in the cases after a two-hour period. We used two batteries of Daniel cells and when these were set up and got into running order it was nearly time to take them apart, wash the zincs and coppers and put the fluids into bottles. As in this process we were likely to splash sulphuric acid on our clothes we kept handy a bottle of ammonia, which was very promptly applied to the stains. At that time I anticipated Dr. Watson in an observation on the conditioned reflex, for when the German student who worked with me drew a mouthful of dilute sulphuric acid through the syphon that we used, he immediately reached for the ammonia bottle and took a mouthful of that.

In the early eighties Wundt's laboratory was housed on the top floor of the *Convict* building, where indigent students had their meals. He used to walk through the laboratory after his lecture, always courteous and ready to answer questions, but, as I remember it, usually limiting his visit to five or ten minutes. He was interested in the laboratory as a system and as a method of introspection, but he was not himself a laboratory worker. His interests were very broad. His "Logik," published from 1880 to 1883, contains in the second edition 1,995 pages; his "Ethik," also published while I was at Leipzig, contains in its third edition 933 pages. The "System der Philosophie," published in 1889, contains in its third edition 738 pages. The last edition of the "Physiologische Psychologie" contains 2,317 pages, the "Völkerpsychologie," 3,161 pages. And they are very large pages.

These books and others Wundt composed on a typewriter that I gave him, one of the first in Germany. Avenarius once remarked that I had by this gift done a serious disservice to philosophy, for it had enabled Wundt to write twice as many books as would otherwise have been possible. At that time the relations of German professors were curious from an American point of view. Wundt was not in friendly relations with Helmholtz, Stumpf, Müller and others. Stumpf, next to Wundt the most distinguished of German psychologists, was professor at Halle, only three quarters of an hour by train from Leipzig, and Wundt was asked for an introduction. He said that he was sorry that he could not give it, as he did not know Professor Stumpf personally; it was better so, for they could then write more freely when there was a difference of opinion—and they did a couple of years later.

At the beginning of the semester students who wanted to undertake experimental work stood before Wundt in a row and from a slip of paper that he held in his hand he assigned topics in order. The year that I appeared there were six or seven of us, representing nearly as many nationalities. I was given the problem of reacting to colored lights; first when the light was seen, and second when the color was distinguished, and by subtracting one time from the other of obtaining what Wundt called the "Apperceptionszeit." This I could not do, but the problem was most useful to me, for it led me to realize the limitations of introspection and to base my work on objective measurements of behavior. Wundt's refusal to admit any subject to the laboratory except a psychologist who could use the results introspectively was

also useful, for it led me to transfer the work to my rooms and make there the first psychological measurements of individual differences and to attempt to develop the useful applications of psychology—with both of which efforts Wundt had no sympathy.

Wundt rejected as a doctorate dissertation Münsterberg's very able monograph on "Die Willenshandlungen" because it did not coincide with his own theories. He calls Stanley Hall's excellent sketch of his life and work an "erdichtete Biographie die von Anfang bis zu Ende erfunden ist." But such things were only the righteous indignation of the Hebrew prophet denouncing the enemies of the Lord. The academic life in Germany in those days was exalted. The nation, the university, the professor, were sacrosanct. It was a fine experience to be admitted to the outer court of the temple before the money changers had entered. Wundt himself was the ideal German professor, with boundless learning shading toward the pedantic, fully conscious of his plenary inspiration, yet withal most modest, shy and kindly; a seer before his students, a child at home, a truly great man.

Wundt's laboratory of psychology was international in its reputation and influence, attracting students from all parts of the world, Americans and Russians predominating. In 1892 it received larger quarters and in 1897 was removed to one of the buildings vacated by the Medical School, where fourteen rooms were remodeled for its purposes. In the late eighties there were beginnings of laboratories under Ebbinghaus at Berlin, under Müller at Göttingen, and under students of Wundt who were my contemporaries and friends, Münsterberg at Freiburg, Martius at Bonn, and Lehmann at Copenhagen.

The second laboratory of psychology was organized by G. Stanley Hall at the Johns Hopkins University early in the year 1883. I was there before Hall, holding a fellowship in philosophy, this award for a thesis on Lotze having been made by the professor of Latin, who knew even less about philosophy than I did, or the fellowship would have been given to John Dewey. He was there as a student, as were also Joseph Jastrow and H. H. Donaldson. We helped Hall set up a modest laboratory in a private house adjacent to the center of ugly little brick buildings and great men that formed the university. The small group of professors working there included Remsen, Rowland, Sylvester, Gildersleeve, Haupt, Adams, Brooks and Martin.

It is a curious fact that neither of the founders of our first two psychological laboratories was a laboratory worker. Hall's chair, like Wundt's, was not limited to psychology; he lectured on philosophy and he also conducted courses in pedagogy. The range of his interests was large, but it was the human aspects of life that he cared for rather than abstract quantitative measurements. Like James he was a man of literary genius swayed by the emotions, which are such a large part of life and as yet such a small part of our science. Minot, the distinguished Harvard embryologist, once said that he envied my occupation with a science concerned with human interests. My reply was that my experiments had as little to do with such things as his had with love and children. Hall wrote about children, adolescence and senescence, religion and sex, the drama of life. He and James were giants in the land, overtowering their descendants of a work-a-day world.

As Wundt established the *Philosophische Studien* to publish the work from his laboratory and his own articles on psychology and philosophy, so Hall established the *American Journal of Psychology*. The early volumes give a survey of the work done in Baltimore, which was largely physiological and psychiatrical. Hall was much interested in insanity and other pathological aspects of psychology and we used to go regularly to the Bayview Hospital for the Insane. These interests were maintained and in the last conversation that I had with him in his lonely house at Worcester he wanted especially to know why orthodox American psychologists cared so little for Freud and psychoanalysis. He showed me a mass of publications and notes that he had collected on the subject.

Hall was called upon to organize Clark University in 1888 and gathered there a group of outstanding scientific men, including Michelson, Webster, Bolza, Neff, Whitman, Mall, Donaldson, Lombard, McMurrich and Boas. The financial support of the university by Mr. Clark was less liberal than had been anticipated and Dr. Harper took over in a body a large part of these men for the faculty of the new University of Chicago. In his "Life and Confessions" Hall remarks: "I felt his act comparable to that of a housekeeper who would steal in at the back door to engage servants at a higher price." Sanford went with Hall from the Johns Hopkins to Clark and became director of the laboratory of psychology which was opened in 1889. The Johns Hopkins laboratory was closed and the apparatus dispersed until it was reestablished by Professor Baldwin and Professor Stratton. Hall and Clark University long maintained a dominant position in psychology and the psychological side of education. In his death there ends the romantic and heroic era of our science.

The laboratory of psychology at the University of Pennsylvania was founded by me in 1887, though it was only in January, 1889, that a special laboratory with adequate equipment of apparatus was opened. The laboratories at Leipzig and the Johns Hopkins were for research, and psychology was only part of the field covered by the professor. At the University

of Pennsylvania a professorship of psychology was for the first time established and laboratory courses for students were for the first time given. It might consequently be argued by a partial advocate that this was the first laboratory of psychology in the sense that Liebig's chemical laboratory at Giessen was the first scientific laboratory. More significant is the circumstance that in this laboratory the research work and the courses for students were based on objective measurements of responses to the environment with special reference to individual and group differences and to the useful applications of psychology, thus leading to the development of modern educational, clinical and industrial psychology.

In 1888 I was also lecturer at Bryn Mawr College and at the University of Cambridge, conducting in both institutions laboratory courses for students. At Cambridge the work was in conjunction with the lectures of Professor James Ward and in the Cavendish laboratory of which the present Sir Joseph Thomson was the director, having just before, at the age of twenty-six, succeeded Maxwell and Rayleigh in the professorship of physics. In the Cavendish laboratory was also set up apparatus for research and this was the beginning of the first British laboratory of psychology. At that time I had the privilege of assisting Galton in the arrangement of the Anthropometric Laboratory in the South Kensington Museum and we began in cooperation the preparation of a book of instructions for a laboratory course in psychology.

The five-year period from 1887 to 1892 is distinguished for the development of laboratories of psychology in the United States. For earlier work tribute should in passing be paid to James McCosh, Presbyterian clergyman from Scotland and president of a Presbyterian college, who at Princeton promoted the study of organic evolution and physiological psychology. George Trumbull Ladd, also a clergyman, was called to Yale as professor of philosophy in 1881 and developed there courses in physiological psychology, leading to the publication in 1887 of his "Outlines of Physiological Psychology." With James and Hall he shares the honor of leading in the development of psychology in America. The laboratory at Yale was organized by Professor Ladd in 1892 with Dr. E. W. Scripture as instructor.

Work in experimental psychology leading to the establishment of a laboratory was begun by Professor Joseph Jastrow at Wisconsin in 1888. His service as professor of psychology is the longest in the history of our science. A year or two later laboratories were established at Indiana University by President W. L. Bryan, at the University of Nebraska by Professor H. K. Wolfe, at Brown University by Professor E. B. Delabarre and at Stanford University by Professor Frank Angell. Professor J. Mark Baldwin was called to Toronto in 1890 and established there a psychological laboratory, as he did at Princeton when he returned to that university in 1893. In 1895 we together founded the *Psychological Review*, which, with its children, *The Psychological Monographs, The Psychological Index, The Psychological Bulletin,* the *Journal of Experimental Psychology,* and the newly established *Psychological Abstracts,* have now, through the generous cooperation of Professor Warren, been acquired and are being conducted by the American Psychological Association.

The professorship of psychology and the laboratory of psychology at Columbia University date from 1891. There worked Professor Thorndike, Professor Woodworth and many others who have led in the development of modern psychology. The following year is notable for the establishment of the psychological laboratories at Harvard and Cornell and the calling to America of Hugo Münsterberg and E. B. Titchener. At Cornell the traditions of the Leipzig laboratory have been best maintained. Titchener brought to us the scholarship of the Oxford don and the research ideals of the German professor. Now he has followed James, Hall and Münsterberg, leaving the world more drab and empty.

Where were James, Royce and Münsterberg was the center of psychology. James was appointed professor of psychology at Harvard in 1889, having been from 1872 to 1880 instructor and assistant professor of comparative anatomy and physiology, after 1880 assistant professor of philosophy, becoming again professor of philosophy in 1897. His great work, "The Principles of Psychology," was published in 1890. In a letter addressed to me as editor of SCIENCE in 1895 James thus tells of the development of work in experimental psychology at Harvard: "I, myself, 'founded' the instruction in experimental psychology at Harvard in 1874–5, or 1876, I forget which. For a long series of years the laboratory was in two rooms of the Scientific School building, which at last became choked with apparatus, so that a change was necessary. I then, in 1890, resolved on an altogether new departure, raised several thousand dollars, fitted up Dane Hall, and introduced laboratory exercises as a regular part of the undergraduate psychology-course. Dr. Herbert Nichols, then at Clark, was appointed in 1891 assistant in this part of the work; and Professor Münsterberg was made director of the laboratory in 1892."

With the publication of James's "Principles of Psychology" in 1890, the opening of the laboratories at Harvard, Yale and Cornell in 1892, and the establishment of the American Psychological Association

in the same year, the earlier period of psychology in America may be closed. The few survivors may look back upon it as the golden age of our science, but that is doubtless due only to the presbyopia that obscures the vision of objects near at hand. In the thirty-five years that have since passed the number of our workers in psychology has increased to an extent perhaps without parallel in any other country or in any other science. We welcome the opening at Wittenberg College of a new laboratory which, under the direction of Professor Reymert, will become a new center for psychological teaching and research.

J. MCKEEN CATTELL

WILLIAM BARNUM

THE Carnegie Institution has recently lost two of its most illustrious friends—Charles D. Walcott and William Barnum. By a strange coincidence both of these men came from Utica, New York, both were pillars in the formative period of the Carnegie Institution of Washington, and they died within a few months of each other. Dr. Walcott was a trustee of the institution since its founding and Mr. Barnum its editor since 1903.

It was in June, 1904, the school holidays, that the writer was given a little note in pencil written by Dr. Walcott and addressed to Mr. Barnum. The gist of the note was "and here is the red-headed boy of whom I spoke this morning." That summer holiday job stretched itself through the years to the present time.

To have worked beside such a man as William Barnum in these past years was an education in itself; to have felt the inspiration that seemed to generate from a noble soul was a blessing indeed; but to have known what this man meant to hundreds of others, to all who came in intimate contact with him, was to know a man the like of which one sees none too often.

Withal, William Barnum was a practical man. Assistance he would render to any one—provided it was an intelligent request. He despised the bluff or insincere. As editor, he would take a fifty-page pamphlet and perhaps reduce it to ten pages. Fine phrases in science writings do not necessarily bring out new information, and Mr. Barnum was an expert in aiding the author to express his thoughts. So too would he turn tables in such a fashion that the author thought the editor knew more about the subject than he did. The late Dr. Alfred G. Mayor, a prolific writer and a most sincere scientific writer, too, relied wholly on Mr. Barnum's judgment in his institutional writings.

The three presidents of the Carnegie Institution of Washington, Dr. Daniel C. Gilman, Dr. Robert S. Woodward and Dr. John C. Merriam, valued and depended upon the great abilities of Mr. Barnum. Dr. John C. Merriam has recently extolled his ability.

As editor of the publications of the institution for nearly a quarter of a century, William Barnum's monument is a library of over five hundred volumes on nearly every scientific subject, the author of each book a debtor to the editor.

The writer would pay a tribute to his friend if he knew how. Perhaps the memory of him in years to come will compensate for my lack of ability to do him justice.

IRVING M. GREY

SCIENTIFIC EVENTS

THE ENLARGED PROGRAM OF FOREST RESEARCH

THE McSweeney-McNary bill, which became a law with the approval of the president on May 22, represents the most important piece of fundamental forestry legislation enacted since the Clarke-McNary law of 1924, according to a statement by Secretary of Agriculture Jardine, who also said:

> Forest research has hitherto failed to keep pace with many other forestry activities, notwithstanding the fact that research is the foundation upon which forestry development should be built. A greatly enlarged research program is called for by this situation, and the comprehensive policy of forestry research provided in the new bill will enable the department to cooperate with other agencies in a definite and far-reaching program of investigations which will form the basis for a permanent system of forest production and utilization for the entire nation.

The new bill establishes and outlines a ten-year program for forest research. A little more than $1,000,000 is now being expended by the federal government each year for this purpose. Under the terms of the McSweeney-McNary bill this amount may be increased each year by about $250,000 until the maximum annual expenditure of $3,500,000 is reached. All classes of forest research are contemplated by the bill, including investigations in growing, managing and utilizing timber, forage and other forest products, watershed protection, fire prevention, insects and disease. The various lines of research contemplated will be conducted by several bureaus of the department, including the Forest Service, the Bureau of Plant Industry, the Bureau of Entomology, the Biological Survey, the Weather Bureau, the Bureau of Chemistry and Soils and the Bureau of Agricultural Economics.

The McSweeney-McNary bill was backed by a widespread, aggressive public interest from all parts of the United States and representing widely diversified groups, including many Chambers of Commerce and

development associations, the lumber and wood-using industries, nature, outdoor and recreation groups and women's clubs.

THE LASKER FOUNDATION FOR MEDICAL RESEARCH

AT the meeting of the board of trustees of the University of Chicago held January 12, a communication from Mr. and Mrs. Albert D. Lasker was presented, in which are set forth the particulars by which is created the Lasker Foundation for Medical Research. The fund thus contributed to the university adds another large endowment for research in medicine, an endowment which provides the means for investigation of notable significance.

Added to the resources of the Douglas Smith foundation, of the Mr. and Mrs. Frank G. Logan fellowships, of the Seymour Coman fellowships (all of which funds are designed to encourage research in various branches of medical science and in the prevention, cause and cure of disease), the new foundation greatly increases facilities and opportunities for medical research.

The Lasker Foundation (established by Albert D. and Flora W. Lasker) consists of $1,000,000, "the net income of which shall be used for the promotion of medical education and research at the University of Chicago." Already a liberal portion of the founding fund has been transferred to the university and the remainder will be paid with interest during the next three years. The offer to pay interest during the period of deferred payment enables the university to begin at once with the full amount of income from the fund the beneficent inquiries and to seek the hoped-for results which are contemplated by the creators of the foundation.

The donors' letter says in part:

> We express the desire that the income from this fund be used in the first place to support research into the causes, nature, prevention and cure of degenerative diseases. In the event, however, that in the opinion of the advisory board—which we shall subsequently mention—and the board of trustees of the university, the income of this fund can be used most effectively for medical education and research in other and further directions, the university shall be authorized to make such changes in the use and purposes of the income derived from said foundation. The general direction of the income shall be determined by an advisory committee, to be appointed by the trustees of the university. It is understood as part of this offer and agreement, and any agreement based thereon, that the publication of researches conducted wholly or partially through the support of this foundation shall, if possible, in the title recite the fact that said research has been supported by the Lasker foundation for medical research.

STANDARD MATHEMATICAL SYMBOLS

APPROVAL of mathematical symbols as American standards has completed the first step in a program of unification of the scientific and engineering symbols and abbreviations used in engineering and industry, under the auspices of the American Engineering Standards Committee. The confusion resulting from variations in symbols used in different publications, reports and tables, led to the initiation of a project of unification by the standards committee early in 1923. The work has been progressing since that time, with 14 national organizations participating.

The approved mathematical symbols include those for arithmetic and algebra, elementary geometry, analytic geometry, trigonometric and hyperbolic functions, calculus, special functions and vector analysis. The effort was made to select from symbols already in use those which are most clearly understood and least likely to lead to confusion with other symbols.

Professor E. V. Huntington, of Harvard University, representing the American Mathematical Society, was chairman of the mathematical symbols subcommittee. This subcommittee is part of the sectional committee on scientific and engineering symbols and abbreviations, of which Dr. J. Franklin Meyer, of the U. S. Bureau of Standards, is chairman. The sectional committee includes other subcommittees on symbols for hydraulics, symbols for heat and thermodynamics, symbols for aeronautics, navigation and topographical symbols, electrotechnical symbols (including radio), symbols for photometry and illumination and symbols for mechanics, structural engineering and testing materials.

THE WEEK ON AGRICULTURE AT THE INSTITUTE OF CHEMISTRY

THE week of July 23, 1928, at the American Chemical Society Institute in Evanston will be devoted to a discussion of the ways chemistry can help agriculture by developing markets for its products other than for food and clothing. To date the twelve speakers listed below have accepted the invitation of the society to take part in the institute sessions during the week of July 23.

W. E. EMLEY: Bureau of Standards, Washington, D. C. He has charge of the work supported by the Department of Commerce on the industrial utilization of farm wastes. He has made a careful and extensive survey of this entire field as to the past and the future.

G. J. ESSELEN, JR.: Skinner, Sherman and Esselen, Boston, Mass. An expert on cellulose. He will discuss cellulose in modern industry and the influence of cellulose on civilization.

H. T. HERRICKS: Color and Farm Waste Division, Department of Agriculture, Washington, D. C. He will dis-

cuss the processes by which moulds are being used to convert corn sugar into valuable materials such as citric acid. It will perhaps soon be possible to go from corn to glucose and then to citric acid more readily than to go from cull lemons to citric acid according to present practice.

H. G. KNIGHT: The new chief of the Bureau of Chemistry and Soils of the Department of Agriculture, Washington. He will take a leading part throughout the week. He will pay special attention to future possible developments of agricultural chemistry along new lines.

C. S. MINER: Miner Laboratories, Chicago. Under his direction furfural has been changed from a chemical curiosity found only in museums to an important industrial chemical sold in tank cars for a few cents a pound. Its largest use is in artificial resins. He will tell how this development took place, but more especially how other similar advances may be made.

A. S. RICHARDSON: Procter and Gamble, Ivorydale, Ohio. His subject will be hydrogenation, the process by which an oil like cotton seed oil is made to unite with hydrogen gas to form a solid fat suitable for cooking.

G. A. RICHTER: Brown Company, Berlin, N. H. On the preparation of pure cellulose from wood. This material can be used in place of cotton cellulose for almost all purposes.

G. M. ROMMEL: New York. An expert agricultural economist, retained by the Department of Agriculture for special studies on farm wastes with special reference to the preparation of cellulose from them.

H. J. SCONCE: Cornstalks Products Co., 42 Broadway, New York, and Danville. The preparation of useful products from farm wastes.

O. R. SWEENEY: Iowa State College. An authority on the preparation of hundreds of useful products from corn stalks and cobs. He is also working with the Department of Commerce on this problem.

A. W. SCHORGER: Burgess Laboratories, Madison, Wis. A leading authority on the chemistry and utilization of cellulose.

R. W. THATCHER: President, Massachusetts Agricultural College. Formerly dean of department of agriculture, University of Minnesota; formerly director of New York Experiment Station. He will present the broader aspects of the subject with special reference to future possibilities.

CHARLES D. HURD,
Executive Secretary.

AWARD OF THE WILLARD GIBBS MEDAL TO PROFESSOR W. D. HARKINS

PROFESSOR WILLIAM D. HARKINS, of the University of Chicago, received on May 25 the Willard Gibbs gold medal, awarded annually by the Chicago section of the American Chemical Society to a chemist whose work in either pure or applied chemistry has received international recognition. The ceremony took place at a national dinner gathering of scientists at the Palmer House.

Professor Harkins delivered an address on "Surface Structure and Atom Building." Professor S. C. Lind, director of the school of chemistry of the University of Minnesota, made the presentation address, discussing "Harkins the Scientist." Professor G. L. Clark, of the University of Illinois, a former student of Professor Harkins, spoke on "Harkins the Teacher and the Man." S. L. Redman, chairman of the Chicago section, discussed "The Willard Gibbs Medal."

Other speakers were: Professor Arthur H. Compton, of the University of Chicago; Dr. Leo Hendrik Baekeland, honorary professor of chemical engineering in Columbia University and former president of the American Chemical Society, New York; Dr. Harrison E. Howe, of the National Research Council, editor of *Industrial and Engineering Chemistry*, Washington; President Max Mason, president of the University of Chicago, and Professor S. W. Parr, of the University of Illinois, president of the American Chemical Society.

Previous Willard Gibbs medallists have been: Svante Arrhenius, T. W. Richards, L. H. Baekeland, Ira Remsen, Arthur A. Noyes, Willis R. Whitney, E. W. Morley, W. A. Noyes, W. M. Burton, F. G. Cottrell, Madame Curie, J. Stieglitz, G. N. Lewis, M. Gomberg, Sir James Irvine and J. J. Abel.

The 1928 jury which made the award was composed of: Dr. A. D. Little, Boston; Professor F. C. Whitmore, director of the institute of chemistry of the American Chemical Society; Professor J. F. Norris, Massachusetts Institute of Technology; L. M. Tolman, Hammond, Ind.; E. W. Washburn, U. S. Bureau of Standards, Washington; Professor Edward Bartow, University of Iowa; W. Lee Lewis, Chicago; Professor William McPherson, Ohio State University; Professor Julius Stieglitz, University of Chicago; Professor Roger Adams and Professor S. W. Parr, University of Illinois, and Professor Moses Gomberg, University of Michigan.

SCIENTIFIC NOTES AND NEWS

AT a dinner on May 23 the Holley medal of the American Society of Mechanical Engineers was presented to Dr. Elmer A. Sperry for his invention of the gyroscope compass.

ORVILLE WRIGHT, pioneer aviator, would be awarded the distinguished flying cross, the highest award for American aeronautical achievement, under a bill introduced in congress by Representative James, of Michigan.

FOR outstanding service to his profession, Dr. Charles H. LaWall, dean of the Philadelphia College of Pharmacy and Science, was awarded the Rem-

ington medal, at a dinner given in his honor at the Hotel Pennsylvania, New York, on May 14.

THE American Academy of Arts and Sciences has announced the election of new foreign honorary members including Friedrich Paschen and Wolfgang Kohler, of Berlin; Soren Peter Lauritz Sorensen and Carl Hansen Ostenfelt, of Copenhagen; Guglielmo Marconi, of Bologna; Francis Arthur Bather, Alfred Barton Rendle, Charles Tate Regan, Karl Pearson and Richard Burden Haldane, of London; Louis Dollo, of Brussels; D'Arcy Wentworth Thompson, of St. Andrews; Mikinosuke Miyajima, of Tokio; Henri Louis Bergson, of Paris; Benedetto Croce, of Naples; Edmund Husserl, of Freiburg; Hans Oertel, of Munich, and Arthur Cecil Pigou, of Cambridge.

IN connection with the celebrations commemorating the twenty-fifth anniversary of the foundation of the University of Liverpool honorary degrees have been conferred, among others, upon Dr. J. A. Fleming, emeritus professor of electrical engineering, University College, London; J. E. Littlewood, lecturer in mathematics, Cambridge University, and on Dr. Robert Robinson, professor of organic chemistry, Manchester University.

HONORARY degrees are to be conferred by Cambridge University upon Professor A. Einstein, Professor Cumont, Professor W. A. Craigie, Lord Lugard, Lord Justice Scrutton, Sir Cecil Hurst and Sir D. Y. Cameron.

PROFESSOR A. G. TANSLEY, Sherardian professor of botany in the University of Oxford, has been elected a member of the Athenaeum Club for distinguished eminence in science.

M. JOSEPH AUCLAIR was recently elected a correspondent of the Paris Academy of Sciences in the section of mechanics.

DR. WALTHER HORN, director of the department of entomology in the Kaiser Wilhelm Institute, Berlin, has been made a corresponding member of the Hungarian Entomological Society, Budapest.

THE eightieth birthday of Professor A. P. Karpinsky, the well-known Russian geologist, president of the Academy of Science, was recently celebrated in Leningrad.

AFTER ten years' service as dean of Cornell University Medical College, Dr. Walter L. Niles, about to retire, was presented with a bronze plaque by the College Alumni Association at its annual dinner in the Hotel Commodore on May 10. On May 23 Dr. Niles was tendered a dinner at the Waldorf Hotel by the faculty of the college.

PROFESSOR HENRY H. WING, professor of animal husbandry in the college of agriculture at Cornell University, will retire in June after forty years on the faculty.

DR. R. E. SCHUH, professor of geology in Howard University, is resigning after twenty-one years of service.

THE following officers have been elected for the American Section of the Society of Chemical Industry: *Chairman,* Charles Lunn; *secretary,* Foster Dee Snell; *treasurer,* F. C. R. Hemingway; *new members of the executive committee,* Samuel Cabot, Moritz Dittmar, L. V. Redman, R. T. Baldwin and Stephen P. Burke.

THE Southern Appalachian section of the Society of American Foresters recently elected the following officers: *Chairman,* Dr. C. F. Korstian, silviculturist, Appalachian Forest Experiment Station; *vice-chairman,* M. A. Mattoon, supervisor, Pisgah National Forest; *secretary,* F. W. Haasis, assistant silviculturist, Appalachian Forest Experiment Station.

AT the recent convention of Sigma Pi Sigma, national honorary physics fraternity, the following officers were elected: *President,* Professor C. C. Hatley, of Duke University; *vice-president,* Professor R. C. Young, of the College of William and Mary; *secretary-treasurer,* Professor Marsh W. White, of The Pennsylvania State College; *councilors,* Professors J. M. Douglas and W. N. Mebane, Jr., of Davidson College.

PROFESSOR OLLIE E. REED, head of the dairy husbandry division of the Michigan State College of Agriculture, has been appointed chief of the Bureau of Dairy Industry of the U. S. Department of Agriculture. He will take up his duties in Washington about September 1. The position has been vacant since the first of the year, when Dr. C. W. Larson resigned to become director of the National Dairy Council.

DR. OSCAR C. WILLHITE has been appointed chief of the neuropsychiatric division of the United States Veterans Bureau at Washington, D. C., to succeed Dr. L. M. Wilbor.

GEORGE N. SCHRAMM, assistant physicist in the electrochemical section of the U. S. Bureau of Standards, has taken a position as research chemist in the Vandergrift, Pa., laboratory of the American Sheet and Tin Plate Company, and will conduct research on the corrosion of iron and steel.

H. W. HOOTS recently resigned as a geologist in the U. S. Geological Survey to engage in commercial geology.

LOUIS O. SORDAHL, research assistant in physics at the University of Wisconsin, has been appointed field assistant of the Smithsonian Institution's station for the study of solar radiation at Mount Brukkaros, Africa, and not director as was incorrectly reported in SCIENCE and other publications.

PROFESSOR HARLAN T. STETSON, of the Harvard Astronomical Laboratory, has been appointed exchange professor from Harvard University to Carleton, Grinnell and Pomona Colleges for the second half of the next academic year.

ACCORDING to the *Journal* of the Washington Academy of Sciences, Dr. E. G. Zies, of the geophysical laboratory, Carnegie Institution, will spend several months in the Dutch East Indies, in a study of the gases and other volatile products of the volcanoes of that region. Messrs. E. T. Allen and C. N. Fenner will spend the summer in a chemical and geological study of the geysers and hot springs of the Yellowstone National Park.

MEMBERS of the third University of Michigan Greenland Expedition are sailing on the *Stavangerfjord* on June 5. Dr. William H. Hobbs, director of the expedition, has already left the United States and will join the other members in Copenhagen and sail on the *Disko* about June 15 for their base at Holstensborg, Greenland.

AUSTRALIAN newspapers note that Dr. Frank Blanchard and his wife, Dr. Frieda Cobb Blanchard, both of the University of Michigan, are spending 1927–28 studying the fauna and flora of Australasia, particularly the mountainous temperate portions of New Zealand, Tasmania and Australia. They also intend spending some time on the Great Barrier Reef, Queensland. Dr. Blanchard is studying particularly the herpetology of Australasia, and Mrs. Blanchard the flora of the cooler portions, with a view to securing plants suitable to the conditions of the botanical gardens of the University of Michigan, of which she is assistant director.

C. W. GILMORE, curator of vertebrate paleontology in the U. S. National Museum, left on May 12 to take charge of an expedition in the Two Medicine Formation of Montana, in search of dinosaur and other vertebrate remains, which will be in the field for two and a half months.

DR. C. POULSEN, of the Mineralogical Museum, Copenhagen, spent April and May at the U. S. National Museum in connection with his study of the Silurian fossils collected in North Greenland by Dr. Lauge Koch.

DR. RUSSELL L. CECIL, assistant professor of clinical medicine at the Cornell University Medical College, delivered the commencement address at the Medical College of Virginia, Richmond, on May 29. On this occasion the honorary degree of doctor of science was conferred upon him.

H. E. HOWE, editor of *Industrial and Engineering Chemistry*, Washington, D. C., during the months of April and May has made a number of addresses before groups of engineers, college students and luncheon clubs in Oklahoma, Missouri, Minnesota, Illinois and Pennsylvania, emphasizing various applications of scientific research to industrial achievement.

DR. JEROME ALEXANDER addressed the New England Association of Chemistry Teachers at their 109th meeting at Wesleyan University, Middletown, Conn., April 19, on "Colloid Chemistry and its Applications." Films were shown which were loaned by Dr. Alexis Carrel and Mr. Heinz Rosenberger, of the Rockefeller Institute for Medical Research.

DR. R. W. BOYLE, dean of faculty of applied science in the University of Alberta, addressed the Philosophical Society of Washington on "Ultrasonics," on May 26.

DR. E. S. LONDON, professor of physiology in the University of Leningrad, gave two illustrated lectures under the joint auspices of the Institute of Medicine of Chicago and the University of Illinois College of Medicine on May 3 and 4, on "Experimental Fistulas of Blood Vessels" and "Enzymes, Hormones and Vitamins."

SIR JAGADIS BOSE lectured at University College, London, on "The Motor Mechanism of Plants," on May 8 and demonstrated by new types of sensitive recorders the contractility and rhythmic pulsations of plants.

AT the last meeting of the University of Pennsylvania chapter of the Society of the Sigma Xi, on May 9, the following minute was unanimously adopted: "This chapter of the society of the Sigma Xi sincerely mourns the passing of Edgar Fahs Smith, former provost of the University of Pennsylvania, for many years a most highly valued member of this society. In his going, science loses one of its most distinguished servants, and the many who enjoyed his friendship lose a rare blessing."

A COPENHAGEN message reports the death of Dr. C. G. Johannes Petersen, for 40 years director of the Danish Biological Station. Dr. Petersen had been associated with Danish fishery research work since 1883, and was known for his investigations of the life history of various food-fishes.

THE eighty-fourth annual meeting of the American Psychiatric Association will be held at the Hotel

Radisson, in Minneapolis, on June 5, 6, 7 and 8, under the presidency of Dr. Adolf Meyer, of Baltimore, Md. The program will cover such subjects as administration, mental hygiene, pathology, clinical psychiatry, phylogenetics, psychoanalysis and psychopathology, with round-table discussions in addition to the regular meetings. A feature of the meeting will be the annual address by Professor Roscoe Pound, dean of the Harvard Law School.

THE Chemistry Research Club met on May 17 in the Natural History Museum, New York City. It was voted to make application to become an affiliated society in the New York Academy of Sciences. Professor Arthur E. Hill, of New York University, read a paper on "The Alkali Periodides." Dr. K. G. Falk, of the Harriman Research Laboratories, read a paper on "Lipase Actions in Normal Tissues and Tumors," in which he summarized the research which he has carried on in the past ten years.

THE third symposium on general organic chemistry will meet at Princeton University late in December, 1929, under the auspices of the division of organic chemistry of the American Chemical Society. The executive committee of the division consists of William Lloyd Evans, Frank C. Whitmore, F. B. Dains, E. Emmet Reid and James B. Conant.

THE annual meeting of the Chicago Neurological Society was held at the Billings Memorial Hospital on May 17. Among others, Drs. Anton J. Carlson, Arno B. Luckhardt, Dallas B. Phemister, John Favill and Roy R. Grinker spoke. The president of the society invited the members to be his guests at dinner at the Shoreland Hotel.

A GEOLOGICAL field conference was held in northwestern Arkansas on May 12 and 13, under the auspices of the department of geology of the University of Arkansas. About 50 geologists were present, representing Arkansas, Oklahoma, Kansas, Missouri and Nebraska. Formations of late Mississippian and early Pennsylvanian age were studied.

THE Alpha Gamma chapter of Phi Sigma was installed at the University of South Dakota on May 15 by Professor Don B. Whelan, of the department of entomology of the University of Nebraska.

ON May 11, a public address was given under the auspices of the Maryland chapter of the Society of Sigma Xi by Dr. F. C. Whitmore, chairman of the division of chemistry of the National Research Council. His subject was "The Habits of the Atoms." On May 18, the first annual initiation and banquet was held. Twenty-four active and associate members were initiated. Dr. William Crocker, director of the Boyce-Thompson Institute for Plant Research, delivered the address of the evening. His subject was "The Work of the Boyce-Thompson Institute."

PLANS for participation of the United States in the World Engineering Congress in Tokio next year were formulated at a meeting of the American committee at the Carlton Hotel, New York, on March 22, following a dinner tendered to the committee by the Japanese Ambassador, T. Matsudaira. Officers elected by the committee follow: *Honorary chairman,* Herbert Hoover; *chairman,* Elmer A. Sperry, New York; *vice-chairman* and *chairman of the executive committee,* John W. Lieb, New York; *vice-chairman,* C. E. Grunsky (Pacific Coast), San Francisco; C. E. Kettering (Middle West), Detroit; *executive secretary,* Maurice Holland; *executive committee,* Gano Dunn, New York; George W. Fuller, New York; Maurice Holland, New York; Dugald C. Jackson, Cambridge, Mass.; Frank B. Jewett, New York; John W. Lieb, New York; J. H. McGraw, New York; O. C. Merrill, Washington D. C.; Calvin W. Rice, New York; Charles F. Scott, New Haven; Dr. Sperry, Brooklyn; W. E. Wickenden, New York; *finance committee,* John W. Lieb; *technical program committee,* D. C. Jackson; *transportation committee,* F. B. Jewett; *entertainment committee,* O. C. Merrill; *publicity,* J. H. McGraw; *promotion and attendance,* George W. Fuller; *nominating committee,* Gano Dunn.

JAMES L. CLARK, of the Carlisle-Clark African expedition of the American Museum of Natural History, sailed from New York on May 9 to get material for the Akeley African Hall of the museum. They will proceed to Nairobi, British East Africa, the expedition's headquarters, where they will meet G. Lister Carlisle, Jr., who left New York with Mrs. Carlisle on April 1. W. R. Leigh, an artist who accompanied the late Carl Akeley to Africa, and C. C. Raddatz, of the department of preparation, will also be members of the expedition. Leaving Nairobi the expedition will spend at least four months in the field, then go out through Uganda and the Sudan to Khartum and across the desert to Wadi Halfa on the second cataract of the Nile, and from there travel down the river to Cairo.

PHYSIOLOGICAL optics as a study for scientific study and instruction has received important recognition at the Wilmer Ophthalmological Institute, the Johns Hopkins University School of Medicine. On October 1, 1928, carrying out the provisions of a special gift, a research laboratory will be opened, designed and equipped for the study and investigation of all phases of pure and applied physiological optics. The work of this laboratory will be conducted by Dr. C. E. Ferree, professor of experimental psychology and director of the psychological laboratory at Bryn Mawr

ical medicine at the Cornell University Medical College, who has been appointed resident lecturer in ophthalmology and director of the research laboratory of physiological optics; and by Dr. Gertrude Rand, of Bryn Mawr College, who has been appointed associate professor of research ophthalmology.

Psychiatric Association will be held at the Hotel

THE Fleischmann mammal wing of the Santa Barbara Museum of Natural History was opened on April 3. This new portion of the building is the gift of Major Max Fleischmann, who recently returned from a hunting expedition to French Indo-China. Four large habitat groups were completed in time for the initial opening of the wing and others are now in progress.

STUDIES of landslides in unconsolidated materials are being begun at the University of Cincinnati, with the intention of determining causes and of considering such factors as angle of slope, soil saturation and mode of movement. Dr. James K. Rogers, of the department of geology, would like to hear from readers of SCIENCE who know of the location of landslides in unconsolidated material in the states east of the Mississippi.

A TRUST fund for the maintenance of neurological research at the Wistar Institute of Anatomy, Philadelphia, has been established by Mrs. Carlos F. MacDonald, widow of the New York psychiatrist, who died on May 29, 1926. The amount of the fund was not made public, but it is to be increased to several hundred thousand dollars.

A COLLECTION of medical books containing many of the earliest printed works on the subject, brought together by Dr. E. C. Streeter, of Boston, over a period of twenty years, has been purchased by the New York Academy of Medicine. The purchase price was $185,000, of which $85,000 was contributed by the Rockefeller Foundation. Fellows of the academy contributed an additional $10,000 and other large contributors included Edward S. Harkness, $25,000; Carl Tucker, $10,000; Mrs. Walter S. Ladd, $10,000; Felix Warburg, V. Everit Macy and Harry P. Whitney, $5,000 each; Clarence A. Mackay, $2,000, and Dunlevy Milbank, Jeremiah Milbank and Harry H. Flagler, $1,000 each.

DELIVERY of the William Libbey geographical library to the Clark University library has been completed. The Libbey library was presented to the university as a memorial to Dr. William Libbey, late professor at Princeton, by his widow, Mrs. William Libbey. Before his death, Dr. Libbey left instructions that his collection of geographical material be placed in an institution promoting geographical research. Mrs. Libbey decided in favor of Clark University. The library of Dr. Libbey contains about 8,000 volumes, including leading geographical publications of Germany, France, Great Britain and the United States. The gift to the university library also includes the Libbey card catalogue of all the important articles in geography that have been published. The collection also includes 14,000 lantern slides with views from all parts of the world, accompanied by a full index to the slides.

UNIVERSITY AND EDUCATIONAL NOTES

FRANK G. TALLMAN, vice-president of the E. I. du Pont de Nemours Company, has made a gift of $100,000 to Bowdoin College, to establish the Tallman lecture fund as a memorial to the Bowdoin members of his family. The income is to be used to provide visiting professors and lecturers.

GROUND-BREAKING ceremonies for the George Herbert Jones chemical laboratories, at the University of Chicago, were held on May 29. Mr. George Herbert Jones, director of the Inland Steel Company, whose gift of $665,000 made the chemistry laboratory possible, was one of the speakers at the ceremony. President Max Mason and Professor Julius Stieglitz, head of the department of chemistry, also gave addresses.

ALBANY MEDICAL COLLEGE, Albany, N. Y., has announced plans to raise a $2,000,000 endowment fund.

DR. KENYON S. BUTTERFIELD, president of Michigan State College, has resigned and Dr. R. Shaw, dean of agriculture in the college, has been appointed his successor.

EARL D. HAY, head of the department of mechanical and industrial engineering at the University of Wyoming, has been appointed to a similar position at the University of Kansas.

DR. CAREY CRONEIS, instructor in geology at Harvard University, has been appointed assistant professor of paleontological geology at the University of Chicago, where he will have charge of the work in invertebrate paleontology, succeeding in that field the late Professor Stuart Weller. Dr. Croneis will conduct the field courses in geology in Missouri this summer and begin his full-time work in Chicago in October.

AT Yale University, the following have been promoted from the rank of instructor to assistant professorships: Dr. Harold Kirby, Jr., biology; Francis Thomas McNamara, electrical engineering, and Frederic William Keator, mechanical engineering.

DR. A. SCHMINCKE, of Tübingen, has been appointed professor of pathology at Heidelberg.

DISCUSSION AND CORRESPONDENCE

ARCHIMEDES AND TRIGONOMETRY

ARCHIMEDES (287–212 B. C.) is commonly regarded as the greatest mathematician of antiquity, but it is only recently that he has been credited by modern writers on the history of mathematics with fundamental developments in trigonometry. Our text-books on this subject usually refer to the Greek astronomer, Hipparchus, who lived about a century later than Archimedes, as the founder of trigonometry. It should therefore be of wide interest to note here that recent discoveries relating to the works of Archimedes, especially to one devoted to the heptagon, seem to establish the fact that we now have more substantial reasons for regarding Archimedes as the founder of trigonometry than we have for giving this credit to Hipparchus. In particular, Archimedes seems to have known rules which are equivalent to our common formulas for the sine and the cosine of the sum and the difference of two angles.

In a recent number of the *Archiv für Geschichte der Mathematik, der Naturwissenschaften und der Technik,* Volume 10, page 432, the well-known German writer on the history of elementary mathematics, Johannes Tropfke, discusses at considerable length some of the necessary modifications relating to the history of trigonometry which result from the recent discoveries as regards the work of Archimedes. He points out, in particular, that Archimedes knew the rule which is now commonly expressed by the following formula:

$$\sin\frac{A}{2}=\sqrt{\frac{1-\cos A}{2}}$$

The ancient Hindu and Arabian writers regarded this rule as one of the most important ones of trigonometry, and it has been assumed heretofore that it was probably due to Ptolemy, who used it without referring to its earlier use by others. It is very interesting to note therefore that it now seems to be due to Archimedes, who lived about four hundred years earlier than Ptolemy. The recent discoveries to which we have referred tend also to give additional support to the view that the so-called Heron formula for the area of a plane triangle in terms of its sides is due to Archimedes, and this constitutes another substantial reason for regarding him as the founder of trigonometry.

It should be added that these discoveries relate to Arabian translations and to references found in Arabian works, and it is well known that many such references are unreliable. In the present instance there are, however, many indirect evidences which tend to support these references. At any rate it is interesting to know that discoveries which promise so much for the history of trigonometry have recently been made, especially since the work of writers who preceded Archimedes seems to show clearly that the fundamental rules to which we referred above could not have been known in their times, and hence it does not seem likely that they could have been known long before the times of Archimedes. Such discoveries also tend to emphasize the important fact that the rapid advances which are being made in the history of science are apt to affect our views as regards some of the oldest and most fundamental developments.

G. A. MILLER

UNIVERSITY OF ILLINOIS

REPRODUCTION RATE IN WILD RATS

As a contribution to the subject dealt with by Dr. Donaldson in SCIENCE for March 20, 1925, "Control of Rat Population," we submit the following:

In 1922 the board of health of New Bedford, Mass., at the suggestion of the U. S. Public Health Service, undertook a rodent survey of the town which was carried on for a period of about two years. Two trappers were employed to trap rats in the business portion of the city and along the water front. The rats were brought to the laboratory of the board of health and examined for lesions of plague by one of us (C. S. S.). Since the whole number examined was small (about 6,000) it was possible to extend the examination beyond the mere search for plague. Careful observations of pregnancy in the female and of the number of fetuses were recorded. Of the total number of female rats examined, seven per cent. were found to be pregnant. This percentage varied little from season to season.

The female rat becomes sexually mature at about three months of age and remains fertile until about twenty months of age. The average life-span of the rat is about three years. Thus the period of fertility is approximately one half of the whole life-span. If the rats which were trapped were equally distributed as to age, approximately one half of the females brought to the laboratory would be fertile. The period of gestation in the rat is about twenty-one days. Pregnancy is grossly visible in the exposed uterus for about sixteen days. If the female rats which were trapped were all reproducing at the rate of one litter per year and there was a purely random distribution as above-mentioned, there would be about one chance in forty-five ($16/365 \times \frac{1}{2}$) of finding pregnancy in any female, that is, about 2 per cent. of the females would be pregnant. The fact that 7 per cent. of the rats were found to be pregnant seems to indicate that

rats under the conditions obtaining in New Bedford were bearing at the rate of from three to four litters per year.

Limitation of numbers in nature is thus seen to be accomplished by a restriction of the reproduction rate as well as through the action of natural enemies. In other words, a physiological limit is imposed probably through the influence of nutrition. Trapping or poisoning merely serves to increase the available food supply for survivors.

PAUL EATON,
C. S. STIRRETT

AUGUSTA, GEORGIA
NEW BEDFORD, MASS.

VITAMIN B

Now that the vitamin originally known as "Vitamin B" has been definitely shown to be made up of at least two other vitamins, this laboratory has devised a method of separating these vitamins from each other and thus leaving them in a liquid form which can be easily used.

When these two fractions are fed alone and separately from the basal diet there is only a slight stimulation of growth for two or three weeks and then a gradual decline, but when the two are fed together there is a moderate rate of growth. This rate of growth, however, is not what one expects from the amount used (equivalent to 1.0 gm of original yeast daily) nor is the rate of growth comparable to that produced by the original yeast. In looking about for an explanation it was thought that possibly the yeast-residue contained the missing factor. A check lot of rats was given this yeast-residue, but instead of a good growth there was slight growth for about two weeks and then a decline and death. However, when these two other vitamins were added to the yeast-residue and the same fed to rats, excellent growth resulted. This new substance found in the yeast-residue after the two other vitamins have been removed meets all the definitions of a vitamin. It appears to be thermostable, and insoluble in water. It activates the two other vitamins of the vitamin-B complex and causes a greater growth than the two alone.

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WHAT IS OSMOSIS?

THE recent edition of the text-book of General Botany by Holman and Robbins states:

> The word osmosis has been given such a variety of meanings by those who have used it that it has lost any precise meaning whatever. As far as possible we shall avoid its use.

That it has been badly used, or rather misused, is evident, but should it be abandoned for this reason? The word is applied to a very definite physical phenomenon and has an exact meaning regardless of whether it has been misused or not.

Examination of standard text-books of botany reveals the source of the present status of the term. A single illustration will suffice. One widely used text states:

> Diffusion through a membrane is osmosis. When two fluids (liquids or gases) of different densities are separated by a porous membrane, diffusion through the membrane will take place until equilibrium results. The diffusion will be more rapid from the less dense to the more dense fluid.

The use of the term *dense* in this connection is meaningless. Students usually interpret it in terms of viscosity, a condition unrelated to osmosis. If it be considered to mean specific gravity then again the definition will not account for the direction of movements of all materials, for the dissolved salts of an egg, to use the illustration given in connection with this definition, will diffuse out into the water in which the egg is immersed at the same time water diffuses in. In this case, however, the movement is from the egg or "denser" medium, to the water or "less dense" medium. Therefore, the "law" is not applicable and consistent for the relatively simple example used to illustrate the process.

Any discussion introducing such terms as "dense solution," "less dense solution," "weaker solution," "stronger solution," and similar descriptions of the concentration of materials in a solution is entirely misleading and can but cause confusion.

A clear statement of the principles involved should remove all possibility of misunderstanding and restore to usage a term too important to be discarded.

In the first place osmosis follows the simple law of diffusion in that the direction of major movement of any material is determined by the concentration, *i.e.*, the number of molecules or ions of that material. The general direction of movement is always from a region where the diffusing material is higher in concentration of particles. The particles of the diffusing material are moving in *both* directions through the membrane, but more are moving away from the position in which most are found than are returning.

Materials move independently of each other, no matter how heterogeneous the solution in contact with the membrane may be. In no case are the diffusing particles dependent on the movement of water or any other material for their own movement.

Osmosis, then, can be defined briefly and accurately as diffusion through a membrane, the direction of

major movement being from a region of high concentration to a region of low concentration of the thing diffusing.

Such a definition will apply to all cases of the phenomenon, no matter how complicated. It is easily applied and avoids the misconceptions introduced by the use of inexact terms.

ORTON K. STARK

UNIVERSITY OF WYOMING

A NOTE ON THE PREPARATION OF BIOLOGICAL SPECIMENS BY FILTRATION OF PARAFFIN

IT is only recently that the writer has seen and read No. 233 of the *American Museum Novitates*. This contains an article written by Dr. G. K. Noble and M. E. Jaeckle and entitled "Mounting by Paraffin Infiltration." Naturally I am interested in learning how these authors received the first suggestions of the possibilities of the method and how they have, with diligence and ingenuity, brought it to a high stage of efficiency.

A special reason for my interest in the matter arises from the fact that I may regard myself as the original inventor of the process. In Volume XIX of the *American Naturalist*, issued May, 1885, on page 526, I detailed the manner in which I filled all the tissues of various small animals with paraffin. Among these were small turtles, fishes, lizards, salamanders, mussels and earthworms. Noble and Jaeckle employ some media which were not at my command, but the result to be attained is the same. I congratulate them on their success.

It appears to the writer that economy of time might be effected, especially in the case of the larger specimens, by more use of injections of the hardening and clearing fluids into the body cavities, perhaps also into the alimentary tract, that seat of rapid putrefaction, and even into the blood-vessels. Certainly freshly-killed animals of moderate or large size will in warm weather begin to decay and become bloated by gases before the preserving formalin or alcohol can penetrate the skin and muscles.

OLIVER P. HAY

U. S. NATIONAL MUSEUM,
WASHINGTON, D. C.

SCIENTIFIC BOOKS

Alcohol and Longevity. BY RAYMOND PEARL. Knopf, New York, 1926, pp. xii + 273.

NOT only Professor Pearl's "Friends of the Saturday Night Club" to whom he dedicates this work, but his other friends and indeed the whole alcohol-interested public will find matter of great importance in this volume. It records a unique investigation in human life statistics and makes the results clear, even for the non-scientific reader. Doubtless many careful readers, who are students of the problem, will be surprised at Professor Pearl's finding on page 226:

> "In a fairly large and homogeneous sample of the working population of Baltimore the moderate drinking of alcoholic beverages did not shorten life. On the contrary moderate steady drinkers exhibited somewhat lower rates of mortality, and greater expectation of life than did abstainers."

The problem of the effect of alcohol on the duration of human life is inherently such that we must turn to large groups for our observations and "to the mathematics of large numbers, to the theory of mass phenomena, to interpret safely our observations." Few if any scientific workers to-day doubt the metabolism results of Atwater and Benedict in reference to the utilization of alcohol in the human body. These results have recently been further extended by Carpenter[1] at the Nutrition Laboratory, who has administered alcohol in the form of rectal enemata and finds the same promptness of oxidation as his predecessors. In the well-known study by Dodge and Benedict on the psychological effects of single doses of alcohol it is pointed out that taken the world over there are very many people who "regularly obtain a somewhat larger proportion of their total energy requirement (calories) from alcohol than from protein." Moreover, it is generally agreed now that alcohol is not a stimulant but a depressant. The results of many studies, including those by Dodge and Benedict and more recent ones by the reviewer, have shown that even small or moderate single ingestions of dilute alcoholic beverages tend to slow up and disarrange reflex and voluntary functions particularly at the time when the alcohol in the blood is on the increase. From these results it appears that we have in alcohol an environmental factor which the body can handle at least in moderate quantities, a contribution to nutrition that needs no digestion, that can to some extent replace other food, but that has a characteristic effect on the central nervous system. As a rule, people take alcohol not so much for its calories as for its colorful relaxing influence on mental life. But it is recognized as

[1] Carpenter, Thorne M., "Human Metabolism with Enemata of Alcohol, Dextrose, and Levulose." Carnegie Institution of Washington, Washington, 1925, Pub. No. 369.

an unsuitable potion for a tight rope artist, an aeroplane pilot, or even for that mundane creature the bank cashier. Subjectively time drags less after alcohol; the individual is not so hard to satisfy, his attentional field becomes somewhat narrowed and he experiences an added increment of interest in his own mental states. Will he pay a penalty of shortened life span for this, shall we say, semi-dreamy and often altogether pleasing existence? These are not the words and this is not exactly the line of argument used by Professor Pearl. He does not say that since alcohol exercises a depressant action (has been used for ages as a "night-cap") it might perhaps reasonably be expected to conserve the quota of human energy and spread it out over a somewhat longer time axis, as increasing the average number of hours of sleep might possibly do. The question of voluntary alcohol indulgence and life span is his problem in the present volume.

Professor Pearl states that his interest in alcohol as an environmental agent began about 1916 when he tried experimentally to modify the germ cells of domestic fowl by this agent. The alcohol was given by the inhalation method. The birds were placed in metal chambers which contained alcohol vapor at about the point of saturation. One hour's occupancy of such a chamber was enough nearly to intoxicate the usual bird. Daily treatment with alcohol was continued for two and one half years. The control birds were of course placed in a similar chamber, but without the alcohol vapor. The results were surprising in that the alcohol-treated birds lived longer than the controls, had progeny that showed considerably less prenatal and postnatal mortality, and as treated organisms demonstrated less incidence of such diseases as roup. The autopsy records are reported as showing no clear indications of the ravages of alcohol. Stockard has used precisely the same inhalation method over a long period with guinea-pigs and has obtained results which very closely parallel those of Pearl with domestic fowl. Professor Pearl in commenting on the striking results in reference to roup says, "A possible explanation is that the daily inhalation treatment acts as a disinfectant of the air passages, and the treated birds do not take the disease because its germs are killed or greatly weakened before they have an opportunity to get an effective foothold." The reviewer can see no reason why this same possibility can not be extended to include the treated organism's entire body surface. Aside from this disinfectant action on the skin and feathers, when the bird is first removed from the chamber the rapid evaporation of the alcohol from the body surface can not but exercise through cooling the usual stimulating effect on the skin. The experimental routine of Pearl and Stockard does not eliminate these external factors which can not be appraised without further data. Nevertheless the results on the fowl were surprising and served as a natural starting point in the study of alcohol and longevity in man.

In approaching the human problem one recognizes instantly that it is impossible to prescribe the hour's daily bath in alcohol vapor and most of the other conditions that can in general be so neatly controlled in animal experimentation. It might be supposed that the essential data were reposing in the record books of insurance companies quietly awaiting the coming of the man with the statistical mill. Professor Pearl largely explodes this idea, making clear that such companies in general are not geared to the research drive. They have not the machinery and as a rule have no interest in prying into the daily or occasional practices of their policy-holders after once they have been accepted. Census reports are of course of even less value in the study of this problem. His material has resulted from family history records obtained by trained field workers under his personal direction. At the request of the National Tuberculosis Association he began about 1920 a comprehensive study of factors concerned in the incidence of tuberculosis, "with special reference to genetic elements." The individuals selected for study were very carefully questioned in reference to the use of alcohol and tobacco because of the possible bearing of these habits on tuberculosis. The field workers stated their problem directly to each examinee and it is believed in this way got the most trustworthy frank statements that can be had. Starting with an individual known to be a case of tuberculosis the field worker traced the family history both backward to ancestry and collaterals and forward to descendants and their collaterals. Numerous environmental factors were taken account of. In exactly the same manner individuals known not to be tuberculosis cases were studied. All the material (both groups) "was taken from one socially and economically homogeneous group of the population of the city of Baltimore and Maryland; namely, what might inclusively be called workingmen's families." An item to be included in a history had to be corroborated by the independent testimony of at least two persons acquainted with the individual in question. For each individual studied there is a record for the kind and amount of alcoholic beverages used, the frequency or regularity of use and such habits at different periods throughout life. The field workers had no hint that these data would be used for a study of alcohol and life duration. These items "sharply differentiate the present material from anything available for the study of this problem in the records of insurance companies, or indeed anywhere else, so far as is known to the writer."

When it comes to the matter of classifying the material in reference to amount of alcohol used numerous difficulties are encountered. The first classification into (1) total abstainers, (2) moderate and occasional drinkers, and (3) heavy or steady drinkers, which was used when this material was presented as an appendix in Starling's "The Action of Alcohol on Man," was criticized as too rough a grouping. Hence eight groups are made for the present treatment: abstainers, three moderate drinker classes and four heavy drinker groups. In all these the question has been *the amount* and the degree of *occasional* to *steady* use. Supposedly the question of dilution has figured somewhat in placing a particular person. Another very important factor, which is in effect a matter of dilution, is whether the alcohol is characteristically, for the given individual, taken with or after food or between meals on an empty stomach. Most assuredly it is not just the total of alcohol dumped into the stomach that is worthy of chief note. The conditions that modify the rate of its getting into the blood and so of its gaining access to the various tissues including the central nervous system are highly important here. Together with the amount and rate of ingestion they define the dosage. A good deal of the so-called idiosyncrasy to alcohol probably consists in these varying conditions which modify absorption. If we take the famous hard drinker, Dr. George Fordyce, for whom Dr. Pearl expresses such unrestrained admiration (p. 68), it will be noted that this one-meal-a-day man did not begin on his alcohol until after he had started to eat. And considering the amount that he ate he could (the size of his stomach permitting) drink a great deal without having the gradient of alcohol concentration in his blood reach a toxic value.

Results are analyzed for 2,164 females and 3,084 males. These populations are classified under sixteen racial groups. In general the females distribute themselves 3.1, 29.8 and 67.1 per cents. for heavy, moderate and abstainer classes. For the three classes in the same order males show 27.4, 42.6 and 30.0 per cents. Scandinavian women showed the largest per cent., 17.6, in the heavy class, while Hebrew, Scotch and Welsh and Old American show 0 here. The Hebrew men give the lowest, 8.3, "heavy" value. Between the three general groups there was not much difference in weekly income. Divided into the eight groups we find that the "moderate in amount, unspecified as to frequency" is 86 per cent. men and 14 per cent. women, which indicates that women gave a more accurate account of their habits. In all forms of the "heavy" classes men constitute more than 90 per cent. of these groups.

The data for the 5,248 individuals studied are presented in numerous tables and graphs where various comparisons between different subgroups and against other data are made. Individuals who changed their group status are discussed. Those who decreased drinking show death-rates below the general population, while those who increased are as decidedly above, but this subgroup whose habits changed during life have not been included in the general actuarial calculations. Numerous questions of an actuarial nature are asked and answered and the author defends as justifiable the calculation of life tables from the material under review. In the case of Dr. Pearl's data a person drops out of "the exposed to risk" group only because of death, never because of a "lapsed policy." The material as a whole without distinction as to the several classes of alcohol users and in respect to both sexes shows a higher expectation of life at all ages than does the general white population of Baltimore, which naturally also includes alcohol users. Although the more refined division into eight groups is proposed there is a tendency throughout the discussion to lump all the "moderates" together for comparison against the abstainers. All the tables and curves show them to compare rather closely and in some the "moderates" make a slightly better showing in life expectancy. So it is possible for Professor Pearl to draw the following conclusion which he places in italics: "In the males the death rates for moderate drinkers are slightly higher than those for abstainers from age 30 to age 55 inclusive, but, in my opinion, there is no statistically significant difference in the specific death rates, in the range of age from 30 to about 70, between abstainers and moderate drinkers, in this experience. In the same range of age the heavy drinking group exhibits a markedly higher rate of mortality than either of the other two groups." A particularly interesting comparison is between 94 male abstainers and 113 moderate drinking brothers of the abstainers. The death-rates are a little higher for the moderate drinkers up to the age of thirty-five, while after that they are a little lower.

The earlier evidence on alcohol and mortality is reviewed and there is an extensive chapter on racial effect of alcohol. There is a bibliography of 269 titles a large single fraction of which (Nos. 158–197) relates to alcohol and cirrhosis of the liver as a disputed question. The book is well gotten up and satisfactorily indexed as to subject and author.

Dr. Pearl feels constrained to disclaim more than once "any responsibility for the application of the results of this investigation to the business of individual living." Notwithstanding this no small amount of space is devoted to straightforward arguing for the "moderate use" and in the face of the disclaimer the author has certainly not been fortunate in his se-

lection of a final quotation to end his treatise. Dr. Pearl states it as his firm conviction that carefully conducted research with animals will in the long run produce more reliable and trustworthy evidence as to the effect of alcohol, as such, upon duration of life as such, including human life, than will any human data.

W. R. MILES

STANFORD UNIVERSITY

REPORTS

THE WESTERN COOPERATIVE OIL-SPRAY PROJECT

THE use of oil as an insecticide has increased rapidly during the last few years. Much experimental work has been done by various agencies, but most of this work has not been coordinated in such a way that comparisons could be made. In order partially to overcome this difficulty, a conference of entomologists and chemists was held at Tacoma, Washington, June 30, 1926, chiefly at the instance of J. R. Parker, associate entomologist at the Montana Agricultural Experiment Station. At this meeting, the Western Cooperative Oil-Spray Project was formed. The participants in this project included the Canadian department of agriculture, the agricultural experiment stations of Washington, Oregon, California, Idaho and Montana and the United States department of agriculture. Mr. Parker was named chairman of the organization. As practically nothing has been published regarding the intentions or results of the project, this brief report is presented at this time.

A further conference was held in Spokane, December 5, 1926, which plant physiologists and horticulturists were invited to attend. The oil-spray problem is not merely entomological in scope. The physiological effects of oils on plants must be considered, as well as the chemical aspects of oil-sprays. It was decided to limit the project to work of a fundamental nature, that is, primarily to investigate the effect of various types of oils on insects and plants and to ascertain the best methods of emulsifying the oils. It is believed that work of this nature will be more valuable than work with oil emulsions that may be on the market. In order to coordinate the work, a definite plan was formulated and the investigators were supplied with uniform materials. This has made the work of the various investigators much more comparable than has been the case heretofore. And to quote from the memorandum of understanding between the various agencies, one result of the project has been "to broaden the knowledge of the individual worker by the exchange of ideas and brief annual reports on work accomplished and to establish mutual confidence and to avoid trespass in matters of credit."

One year's work has been completed, and the results have been discussed and further plans made at a meeting held in Spokane, December 17 and 18, 1927. As the agencies involved are chiefly interested in horticultural work, the investigations so far have been limited to fruit trees. Possibly the most striking feature of this work has been the need of careful observations on the part of plant physiologists and horticulturists as to the effect of oil-sprays on trees and their products. This has been more or less overlooked in the past by entomologists, possibly because of their inability to measure carefully such effects.

The project feels that the use of dormant oils is fairly well standardized, and recommendations can be made and have been made regarding their use for the control of the fruit-tree leaf-roller, scale-insects, aphids and red spider eggs. However, there is still much to be learned as to the best time for application and the effect of low temperatures following application, and this portion of the investigation is to be continued.

The use of oil for summer spraying is not well standardized. On account of this, manufacturers are continually changing their products. Good results have been obtained in the control of red spiders and the codling moth, but the application of a number of summer sprays of oil has often resulted in injury, in one form or another, to the trees. For example, the fruit of yellow apples is particularly susceptible to oil injury; and trees in poor physical condition may be more severely injured than those in good condition. Moreover, the use of oil with lead-arsenate may complicate the subsequent removal of the spray residue. For these reasons, aside from the use of a single application of oil of sufficient strength to kill red spiders, no recommendations for using summer oils can be made by the members of this project until further investigations have been carried out.

The members of the project engaged in the 1927 investigations were as follows:

Dominion of Canada, Department of Agriculture:
E. P. Venables, (Entomology), Vernon, B. C.

Washington Experiment Station:
Dr. R. L. Webster, (Entomology), Pullman
E. L. Green, (Chemistry), Pullman
Anthony Spuler, (Entomology), Wenatchee
F. L. Overley, (Horticulture), Wenatchee
W. A. Luce, (Horticulture), Wenatchee

Oregon Experiment Station:
D. C. Mote, (Entomology), Corvallis
B. G. Thompson, (Entomology), Corvallis
R. H. Robinson, (Chemistry), Corvallis
Leroy Childs, (Entomology), Hood River
R. K. Norris, (Entomology), Talent

California Experiment Station:
E. R. deOng, (Entomology), Berkeley
A. D. Borden, (Entomology), Sebastopol
Idaho Experiment Station:
Claude Wakeland, (Entomology), Parma
Montana Experiment Station:
J. R. Parker, (Entomology), Bozeman
Dr. W. C. Cook, (Entomology), Bozeman
H. E. Morris, (Plant Physiology), Bozeman
B. L. Herrington, (Chemistry), Bozeman
United States Department of Agriculture:
D. F. Fisher, (Plant Physiology), Wenatchee, Wash.
H. C. Diehl, (Plant Physiology), Wenatchee, Wash.
C. P. Harley, (Plant Physiology), Wenatchee, Wash.
L. E. Reeves, (Plant Physiology), Wenatchee, Wash.
L. A. Fletcher, (Plant Physiology), Wenatchee, Wash.
E. J. Newcomer, (Entomology), Yakima, Wash.
M. A. Yothers, (Entomology), Yakima, Wash.

At the present time E. J. Newcomer is chairman of the project and Anthony Spuler is secretary.

D. F. FISHER,
E. L. GREEN,
E. J. NEWCOMER, *Chairman*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD FOR CUTTING GLASS TUBING

A THIRD method for cutting heavy glass tubing may be added to those described by Seemann, SCIENCE, No. 1726, and Tolmachoff, SCIENCE, No. 1733.

A piece of stout string about two feet long is wound once and a half around the tube. The two ends are allowed to hang down on opposite sides of the tube. The tube is held in a wooden vise, clamped on a desk with a wooden clamp, or held by a fellow worker, so that the edge of the desk acts as a guide for the string at the point where the tube is to be cut. The two ends of the string are grasped firmly, one end in each hand. The hands are pumped rapidly up and down, keeping the string tightly pulled around the tube. This is continued a short time until the tube and string are hot enough so that the string begins to smoke. Cold water from a beaker is quickly poured on the hot tube causing a clean break. The entire process may be completed in two or three minutes.

J. L. ST. JOHN

DIVISION OF CHEMISTRY,
AGRICULTURAL EXPERIMENT STATION,
STATE COLLEGE OF WASHINGTON

AN INEFFECTUAL ATTEMPT TO DEMONSTRATE THE VACUOME OF CERTAIN PLANT CELLS

IN an investigation concerning the nature of the plant-vacuole the writer had occasion to attempt a silver impregnation of the vacuome of various kinds of cells. The Golgi method of Da Fano was used because it is recommended by Guilliermond. This method involves the following steps:

(1) Fixation of the tissues in Da Fano fluid, a solution of cobalt nitrate in dilute neutral formalin. This fluid has a pH of 6.7.

(2) Impregnation of the tissues with a silver salt solution, silver nitrate.

(3) Reduction of the pieces of tissue thus treated by means of a modified photographic developer, Cajal solution.

(4) The customary procedure of dehydration, infiltration with paraffin, embedding, sectioning, mounting and counterstaining the tissues.

Root-tips of four-day-old wheat, barley and pea seedlings were used. Guilliermond recommends the use of root-tips of barley and pea seedlings.

By means of the Da Fano method, using the concentrations of Da Fano, Cajal and silver nitrate solutions recommended by Da Fano, the writer attempted to demonstrate the vacuome of the cells of the above tissues. In four of the experiments, the concentration of the solutions used was increased and the time of exposure of the tissues to the solutions was increased. Material on 153 slides, each containing from eight to ten sections, was subjected to the Da Fano procedure and examined carefully. In all cases examination of the sections failed to reveal the existence of a silver impregnated vacuome described and sketched by Guilliermond. In a few sections of wheat-root-tips examined, round black granules appeared in the vacuoles of 80 per cent. of the cells of the meristem. These granules resembled very closely in general appearance, distribution and occurrence the granules described by Guilliermond.

Changes in hydrogen-ion concentration of the fixative used, cobalt nitrate in dilute formalin, were tried. This modification has not been recorded by Guilliermond. The solution was brought to pH 2.4, 3.0, 4.6, 7.0 and 8.0 by the use of potassium acid phthalate and potassium dihydrogen phosphate buffer mixtures. The root-tips fixed in these solutions were then submitted to the remaining steps in the Da Fano procedure. Examination of sixty-two slides, twenty-three of barley containing the sections of ten root-tips and twenty-seven of wheat, containing sections of eight root-tips, revealed empty vacuolar spaces. Nuclei of cells of material fixed in solutions of pH 7.0 and 8.0 contained more granules of reduced silver than did those of material fixed in more acid solutions. The cytoplasm of the former cells also contained a much heavier deposit of silver than did that of the latter cells.

The results herein recorded indicate the extreme capriciousness of the method recommended by Guilliermond. The success of the method seems to be a matter largely of chance or depends upon factors which are as yet unknown.

BERNICE BURKHARDT RICE
UNIVERSITY OF MISSOURI

SPECIAL ARTICLES

THE EFFECT OF X-RAYS IN PRODUCING RETURN GENE MUTATIONS[1]

MOST of the natural mutations known in Drosophila are to the recessive condition. With the exceptions of the reversions from bar eye to full eye and possible return mutations at the white-eye locus there is but scant evidence that this is a reversible reaction.

Muller found that gene mutations produced by X-rays are, in general, in the same direction and of the same nature as those occurring spontaneously in the fruit fly. In the numerous mutations arising in his recent experiments as a result of irradiation Muller has only two cases of return mutations—both involving the same factor locus, *scute*. This raises the problem of why it is more difficult to find mutations in one direction than in another.

Mutations by X-rays are also fortuitous or chance occurrences at the present time. The operator may be likened to a hunter shooting birdshot into a flock of ducks. As the hunter "accepts with natural piety" what comes down, so the investigator shooting X-rays into a flock of genes accepts what is given. For it is impossible to aim at any particular gene at the present time.

However, in spite of the infrequency of return mutations to the normal condition and the impossibility of controlling results, it appeared to the writer that an experiment carried out on sufficiently large scale might give the mutation rate of mutant genes to normal and the relative frequency with which certain specific genes are hit.

The problem then was: Return mutations at specific loci due to the action of X-rays.

The males used in the experiment carried five mutant genes in their X or sex chromosome; those for yellow body, white eye, forked bristles, bar eye and Beadex wings. The first three of these are recessive to normal, the other two are dominants. Part of these males were exposed to X-rays, using a dosage of 50 K. V.; 5 M. A. M.; 15 cm from the target and forty-eight minutes' exposure (known in Muller's Lab. as the T-4 treatment). The remainder were treated for twice this length of time (T-8). During treatment the flies were placed in gelatin capsules punctured by a fine needle to admit air.

Immediately following treatment these males were mated to virgin double-X yellow females. These females are peculiar in that the two sex chromosomes are attached at the right hand end and go together into the same gamete, which is equivalent to 100 per cent. non-disjunction. The double-X yellow females also carry a male Y-chromosome. In such a cross the sons get their X-chromosome from their fathers and their Y-chromosome from their mothers, a reversal of the usual procedure in this species. There are several advantages in using a stock made up in this way. Practically all mutations occurring in the sex chromosome of the treated fathers show up in the first generation of sons, whether recessive or dominant, as they are not covered by normal allelomorphs in the Y-chromosome.

One thousand such virgins were mated to irradiated males, two pairs to a bottle. This gave five hundred bottles and after seven days the parents were transferred to new bottles and remained there for seven days more. This gave one thousand bottles of offspring among which to look for changes in the five specific loci described above. Such heavy dosages of X-rays as were used in this experiment decrease productivity to a marked extent. The writer has shown elsewhere that following dosages of the magnitude used here only 12 per cent. of the eggs laid complete their life history.

The following table gives the count of the young hatching in the one thousand mating bottles. The average young per bottle was only 10.7 per cent. Many bottles contained no offspring at all.

	Males	Females	
T–4	3,796	4,811	
T–8	866	1,243	
	4,662	6,054	10,716

Gene mutations apparently are produced by a dosage which is just under that rendering complete sterility.

While an experiment involving one thousand mating bottles is not exactly small in scale the poor viability of rayed males reduces the offspring to a point where extensive results could hardly be expected. This defect is being remedied by a repetition of the work on an even larger scale. However, the results secured at the bar gene locus throw considerable light on a mooted question and seem worthy of record at the present time.

[1] This work was done in the Zoological Laboratory of the University of Texas during a recent sabbatical leave of absence from Washington University. My appreciation for the many courtesies received is hereby expressed to Professor J. T. Patterson and Professor H. J. Muller.

There were no return mutations at the yellow, white or forked loci. Considering the small number of offspring examined and the rarity of return mutations this is not a matter for surprise. There were eight cases of normal wings instead of the expected Beadex wings. These were either extreme overlaps of the beaded characters or somatic mutations. They did not breed true when mated to double-X yellow virgins, but gave again the beaded wings. There were four cases of reversion to full eye, and these bred true to full. Two were in the T-4 group and two in the T-8 group. This is a ratio of one reversion in 433 males in the T-8; one in 1,898 in the T-4. These are the results of the observations upon the five definite loci studied in the X-chromosome of the male offspring.

In addition, approximately one hundred other mutations, mosaics and abnormalities of various sorts were observed. These occurred in both males and females and affected all parts of the body. The strong temptation to preserve and breed everything that turned up was resisted and the original plan of rigidly concentrating on the five loci described above will be adhered to in further work now under way.

The four reversions to full eye at the bar locus are of considerable importance. Zeleny[2] has studied the bar-eye gene very extensively. He found that bar eye reverts to round eye about once in 1,600 times; and also discovered an allelomorph of bar, called ultra-bar, whose reversion rate is approximately the same. Zeleny considered the bar-eye character to be due to a gene mutation not different from other gene mutations in Drosophila. Upon evidence based on the sex ratio Zeleny concluded that mutations to full eye may occur in the male germ tract as well as in the female.

Sturtevant[3] assumes that Zeleny's data indicate that reversion occurs only in the female and reports extensive experiments which seem to show that reversions at the bar locus are due, not to gene changes at all, but rather to unequal crossing-over between the two X-chromosomes of the female. Hence no reversion in the male is possible, since no crossing-over occurs.

According to Sturtevant crossing-over in the bar region occurs in such a way that the respective points of interchange lie to the left of the bar locus in one chromosome, but to the right of it in the other one. Sturtevant made many crosses and all his data, compiled in nineteen tables, indicated that both reversion to round and to ultra-bar eye (called by him double-bar) was due to unequal crossing-over. He also made a count of 10,179 males derived from a cross with double-X yellow females, in which all males got their X-chromosome from the father, and in these males no rounds or double-bars were observed.

Furthermore, Muller and Dippel[4] counted 35,000 sons that had derived their X-chromosome from a bar-eyed father, and in this large number not a single case of reversion to full eye occurred. These results of Sturtevant and Muller and Dippel seemed to warrant the conclusion that mutations to round eye occurred exclusively in the female. And Sturtevant's experiments indicated that reversion to round eye was due to unequal crossing-over in the female and not to a gene mutation such as is responsible for character changes at other loci.

However, that reversions to round eye *are* possible without crossing-over seems proved by the work with X-rays. Muller (unpublished data) got two reversions to round eye in females in cases where there was no crossing-over near the bar locus (between forked and Beadex), one in control material and the other from lightly X-rayed flies. My results (described above) give one reversion to round in 433 males from heavily treated fathers and one in 1,898 males from fathers less heavily treated. These reversions were obtained under conditions which clearly rule out Sturtevant's theory of unequal crossing-over.

It is of interest that a mutation rate of one in 433 males is probably the highest rate of gene change yet reported in *Drosophila melanogaster*.

FRANK BLAIR HANSON

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[2] Zeleny, Charles, 1921. "The Direction and Frequency of Mutation in the Bar-eye Series of Multiple Allelomorphs of *Drosophila*," *Jour. Exp. Zool.*, 34: 203–233.

[3] Sturtevant, A. H., 1925. "The Effects of Unequal Crossing-over at the Bar Locus in *Drosophila*," *Genetics*, 10: 117–147.

[4] Muller, H. J., and Dippel, A. L., 1926. "Chromosome Breakage by X-rays and the Production of Eggs from Genetically Male Tissue in *Drosophila*," *British Jour. Exp. Biol.*, 3: 85–122.

A SPONTANEOUS MODIFICATION OF THE VISCOSITY OF FRESH BLOOD SERUM

IN order to study such unstable solutions as blood serum, it is important to dispose of methods which enable us to follow continuously the evolution of a phenomenon, as a function of time, or temperature, for example, without introducing uncontrollable or disturbing factors. The viscometer described in 1923 (based on the principle of coaxial cylinders) was devised in order to fulfil these requirements, and was used recently to determine the viscosity of fresh normal horse serum, as a function of time. It was found that such a serum, centrifuged immediately after separation from the clot and placed in the viscometer, behaved in the following way: At first, its viscosity, which is

rather high (relative viscosity $\frac{\eta}{\eta_0}$ *i.e.*, ratio of the absolute viscosity, of the solution, to that of the solvent, of the order of 3) generally increases for a short time —say ten minutes—then decreases rapidly, almost proportionally to the time, and finally reaches a stable value, considerably lower than the original one (order of magnitude $\frac{\eta}{\eta_0} = 1,8$). Towards the end, the curve is logarithmic. The total phenomenon requires from one to two hours, as a rule, this time depending mainly, as far as we can see at present, on the amount of handling to which the serum has been submitted.

TABLE I

SPONTANEOUS DECREASE OF THE VISCOSITY OF FRESH BLOOD SERUM (HORSE)

(Exp. N° 10 Ser. N° 3) Time minutes	(Relative viscosity, η) η
0	2.640
5	2.730
7	2.640
10	2.580
15	2.440
20	2.140
26	1.905
30	1.870
35	1.845
40	1.835
45	1.830
60	1.824
70	1.824

Important fluctuations are sometimes observed at the beginning of the experiment. The spot moves jerkily, as if the bob (inside suspended cylinder of the viscometer) were attached to the outside moving cup and suddenly released.

When the spot is allowed to come back to the zero, that is, when the constant speed motor is stopped, during the first minutes of an experiment, it does *not* come back all the way to the zero, but stops at a certain distance—say thirty or fifty divisions of the scale. As the experiment progresses, however, the distance becomes shorter and shorter, and when the stable value of the viscosity is attained, the zero checks perfectly.

It seems to us that the aforesaid facts can readily be accounted for in the following way: the chemical evolution of the serum begins the minute it is separated from the fibrinogen. It has lost its power of coagulating rapidly, but the splitting, if we may be allowed to say so, of the "plasma molecule" leaves a "serum molecule," which does not immediately reach a stable state. The amputation of the fibrinogen exposes certain unstable chemical groups, which rearrange themselves in time by shifting or otherwise. While they are exposed, however, they still retain to a small extent the power of adhering to one another and to form reticular structures in the solution. These structures are invisible even under the ultra-microscope. But they are strong enough to apparently increase the viscosity of the serum, and, when the rotation of the cup is stopped, to prevent the spot from returning to the zero. As time elapses, the number of molecules capable of adhering to one another decreases, and when the transformation is complete, the zero checks, and the *true* viscosity is measured. Before that, what was measured was really viscosity *plus* a kind of plasticity, and the curves obtained express the progressive passage from one state to the other.

This hypothesis seems to account for the observed phenomena. The increase which takes place at the beginning may be due to the fact that handling of the serum (aspirated and poured into the cup by means of a pipette) breaks down the existing structures, which tend to rebuild themselves up as soon as the serum is in the cup; this would also account for the fluctuations described at the beginning of this paper.

This phenomenon is not without precedent in the colloidal world. Certain iron sols will coagulate, and become fluid again on mere shaking. It is known that the so-called "stabchen-sole" studied by Siedentopf, Szegvari and Zocher show the tendency to form structures by sticking to one another. This phenomenon is different from adsorption, as only certain parts of the particle seem capable of sticking, usually the extremities: Orientation of colloidal molecules or particles is one phase of this phenomenon.

We may now understand why, when studying living cells with dark-field illumination, certain particles can be seen in what seems to be a perfectly structureless protoplasm, obviously agitated with brownian movement, but apparently limited in all direction, as a bird in a cage. The bars of the cage are not visible: yet they are there; this explains how difficult it is to measure the "viscosity" of protoplasm, and also why the protoplasm does not flow out of fibroblasts which usually show at the end of one of their arms an "opening" which is not limited by any visible line. The protoplasm is not coagulated, yet it is maintained, not by surface tension, but by these reticular structures.

In finishing this preliminary note, I wish to express many thanks to Dr. Simon Flexner, director of the Rockefeller Institute, for having allowed me to take over the instruments and apparatus which made this work possible.

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SCIENCE NEWS

Science Service, Washington, D. C.

TWO FORMS OF YELLOW FEVER

NOT for months and perhaps years will the medical world be able to estimate the importance and value of the varied researches undertaken by Dr. Hideyo Noguchi, internationally known bacteriologist and latest addition to yellow fever's long list of scientific martyrs.

From the germ cultures he has left, perhaps from samples of his own blood that he insisted be taken from his body for inoculation of monkeys, it may be found whether or not there are two forms of the disease, one American and one African. It may be that when his assistants who are at work on his material have their results ready to give the world, the ancient controversy will be settled and it will be established whether the dread "yellow jack" was one of the New World's questionable gifts to humanity or whether it was brought over from Africa with the importation of slaves.

During work on yellow fever in South America, in 1918, Dr. Noguchi isolated a germ believed to be the cause of yellow fever. From it he developed a preventive vaccine and a causative serum that proved fairly efficacious if used within two or three days after the onset of the disease. Campaigns against the deadly stegomyia mosquito, carrier of the disease, practically stamped out the infection in the Western Hemisphere. Nevertheless, it continued to be a serious menace in West Africa.

Epidemiologists stress the importance of suppressing yellow fever in the west of Africa before a transcontinental railway is opened up to carry the disease to the East. The stegomyia flourishes in the warmer countries of the Orient, and once these mosquitoes became infected the havoc that a disease like yellow fever would wreak amid the unsanitary conditions of India and southern China would be appalling and should be prevented at any cost.

Anxious to smother the disease before it could spread afresh from its last stronghold, the international health division of the Rockefeller Foundation established a laboratory at Lagos, Nigeria, where a trained staff has been at work on the problem for many years. In South America, Dr. Noguchi was able to transfer the disease to monkeys and even guinea-pigs, but workers in Africa found it impossible to inoculate any animals for a long time, a condition that argues in favor of two distinct entities for the disease in the two countries. In all outward aspects, however, they are much alike. Finally Dr. Adrian Stokes, a British investigator at the laboratory at Lagos, succeeded, along with a group of colleagues, in infecting monkeys of the variety known as *Macacus rhesus* with typical African yellow fever. Dr. Stokes also succumbed to the disease. But his work constituted an important step, since it did away with the necessity in studying the African form for volunteer human victims, such as were called for by the U. S. Army Commission in Havana years ago. At the same time the workers were unable to find the causative Leptospira in the patient's blood. It almost seemed as if the two diseases had different origins.

Since Dr. Noguchi was generally conceded to know more about this particular group of germs than any other living person, he undertook the African trip last fall to see if he could personally sort out the two diseases. Perhaps his skilful crippled hands, famous throughout the realm of bacteriology for their technique with test-tube and microscope, could demonstrate *Leptospira icteroides* where others had failed, or even show an entirely different cause. While at work he contracted the disease and died. Whether or not he found what he sought, authorities at the Rockefeller Foundation refuse to affirm or deny. Only after his coworkers and assistants have some concrete results to show from his research will the world know. In the meantime the work at Lagos goes on.

HIGH-FREQUENCY X-RAYS

EXTREME high-frequency X-rays, generated in a million-volt tube, are the next item of promise on the program at the California Institute of Technology. Allied to the investigation of the cosmic rays, which has recently yielded such interesting results, is the attempt, long under way at the institute, at the artificial production of very short waves, and therefore very penetrating radiation. In the hands of C. C. Lauritsen and R. D. Bennett this work has already yielded some promising results.

As yet no apparatus can be devised for handling the terrific electric potential required for the artificial production of cosmic rays. For intermediate rays of about one-twenty-billionth of an inch wave-length, however, there seem to be experimental possibilities. Such rays are much shorter than the surgeon's X-rays and much more difficult to produce.

The X-ray "tube" used in the new work is several yards long, made in sections similar to the glass cylinders used in gasoline dispensing apparatus. Before operation all but one billionth part of its air content is pumped out. A water-cooled anode raised to a potential of a million volts pulls electrons bodily and violently out of the nearby cathode by the application of the principle of "field currents" studied intensively for some years past at the Norman Bridge laboratory by Millikan, Eyring and Lauritsen. Under this terrific force the electrons attain a speed very near to 186,000 miles per second, the velocity of light. Striking the anode at this enormous speed the electrons generate X-rays like the gamma rays naturally emitted by radium.

In preliminary trials now being run in the high tension laboratory of the institute, where a million-volts to ground at a thousand kilowatts is available to the experimenters, Lauritsen and Bennett have succeeded in obtaining continuous operation of their new tube at voltages that have approached the million mark. The high-frequency rays produced were observable through the steel doors of the laboratory more than 100 feet away.

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The physicists of the institute make no pretense of any immediate project beyond an extension of spectrographic studies, long a part of Millikan's program. It is suspected, however, that these new and very difficult experiments are a preliminary skirmish in a further campaign on the nucleus of the atom. It is well-known that the gamma rays of radium are intimately connected with nuclear disintegration and transmutation of elements. The structure of the nucleus is a profound mystery, but there is plausible evidence of enormous forces connected therewith. Electrically the problem is one where voltage is counted in seven and eight figures. Economically the problem suggests fabulous power values as yet wholly within the domain of fancy.

THE EMERGENCY ASSOCIATION OF GERMAN SCIENCE

A GERMAN scientific association, originally organized in the post-war and post-revolutionary emergency to help out hard-pressed scientists and impoverished laboratories, has developed into one of the most active agencies for the promotion of science to be found in Europe.

It still keeps the now somewhat inappropriate name, "Notgemeinschaft der deutschen Wissenschaft," that is, "Emergency Association of German Science." But its present functions, now that times have become a little less stringent, have expanded far beyond its original work of rescue in distress. It is backing half-a-dozen promising ventures in science, in widely varying fields.

Of greatest interest to Americans, perhaps, is the plan now under discussion for the creation of a school for research into the physiological improvement of human beings by means of sports and games. Germans have always been much interested in physical culture, and since the war have taken increasingly to track and field athletics on the American plan. It is the ambition of German athletes to offer a really serious challenge to America for first place in this year's Olympics.

In the realm of industrial science the Notgemeinschaft is supporting research in metals and their properties, under Professor Schenk, of Muenster, Westphalia. He is engaged in examining the plasticity and other properties of metals which offer possibilities of development for science and for the metallurgical industries.

Another field is the investigation of the nutritive physiology of plants, especially questions of manures and fertilizers, and the growth and cultivation of grains and other economic plants.

Exploratory expeditions of purely scientific character are also under way. One goes to Transbaikalia in cooperation with Russian scientific institutions, under Professor Wilmans, of Heidelberg. Another expedition, in association with the Russian Academy of Sciences, is to be sent to the Altai regions on the borders of Siberia and Tibet.

The Notgemeinschaft has interested itself in archeological finds at the ancient town of Trier or Treves, which was once a Roman garrison city. During the construction of a new high school there the foundations of a large Roman building were unearthed, which were shown to constitute a temple area and a praetorium. It is hoped to gather new light here concerning Roman culture in Western Germany.

Similar problems engage attention in the East, where prehistoric earthworks and fortifications have been excavated. Professor Unverzagt, of the Ethnological Museum, Berlin, well known for his excavations at Lossow, near Frankfurt on the Oder, has been working in this field.

STUDY OF THE HARESKIN INDIANS

THE prospect of studying a primitive culture, which has been maintained for thousands of years untouched by outside contacts, is taking Cornelius Osgood, graduate student of ethnology at the University of Chicago, on a 15 months' expedition to the Canadian Barren Grounds, the region around Great Bear Lake. He is *en route* to Waterways, where he leaves the railroad. The 1,000-mile trip from Waterways will be made by canoe and dog team. He expects to reach Ft. Norman, the last outpost of civilization in that region, sometime in August.

Almost nothing is known of the Hareskin Indians, which he will study, except that they are sullen and inhospitable. Two white missionaries who tried to convert them were murdered. Mr. Osgood hopes, if it is possible, to live with them during the long winter season, getting first-hand observations of their manners and customs. The difficult language of the Hareskin tribe presents a problem, but Mr. Osgood expects, if he receives a friendly reception, to make himself understood by using Athabascan word stems. The Hareskin tribe is a member of that linguistic group.

Professor Edward Sapir, University of Chicago anthropologist, believes that this expedition presents "an almost unparalleled opportunity of studying a primitive people who have been uninfluenced by outside cultures." It is hoped that a complete knowledge of this tribe will shed light on the development of other Athabascan tribes, particularly the Navajos, in Arizona and Mexico.

The Barren Grounds lie almost wholly within the Arctic Circle, more than 300 miles from Ft. Norman. The hardships of a winter in this region induced Mr. Osgood to make a 1,300-mile preliminary trip on the rivers north of Edmonton last summer, in order to learn what he may expect. The expedition is being financed by the National Museum of Canada.

THE ROCKET AUTOMOBILE

WITH fire-spurting rockets instead of engine-furnishing power, the Opel rocket car made trial runs on the Avus race course in Berlin, on May 23, reaching speeds of 90 to 120 miles an hour. The small, slightly-built automobile was piloted by Fritz V. Opel. To stabilize it during its speedy travel it has a plane or fin on each side.

A battery of slow-burning rockets, filled with powder, by discharging into the air at the rear of the car, furnished the impulse that drove the car forward. The driver controlled the burning of the rockets and therefore the speed of the car by an ignition foot lever.

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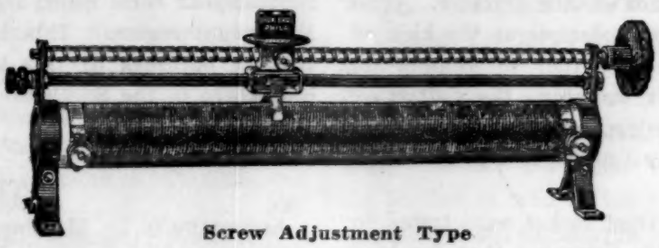

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Each rocket was about a yard long and three inches in diameter and metal cases were used as containers. The curves of the two-mile track were taken without difficulty or danger. Tests of this new sort of automobile are understood to be preliminary to the trials of a rocket airplane designed to reach high altitudes where an ordinary air propeller airplane could not obtain traction. The rocket, operating upon the same principle as the kick of a rifle, does not need the air in order to produce its effect. The rocket principle is, therefore, the method of power that could be used in airless outer space that must be traversed on a journey, a la Jules Verne, to the moon or the planets.

Although interested in the Opel rocket auto tested in Berlin, scientists in Washington point out that for land or air transportation the rocket car will not prove economical when compared with the usual internal combustion engine autos and airplanes. The rocket applies effectively only a small percentage of the fuel's energy, about five per cent., as compared with four to six times that percentage for ordinary automobiles operated on gasoline. For use where there is no air the rocket provides propulsion where other methods can not apply. The idea of applying rocket power to automobiles is not new, for in the past extensive tests have not been made.

THE SEVENTEEN-YEAR "LOCUSTS"

THE seventeen-year cicada, often called the seventeen-year locust, is booked to appear during late May and early June through a wide stretch of territory east of the Alleghenies, from North Carolina up to the Hudson Valley and the Long Island Sound region. In a few spots in the middle west, in southern Indiana and southern Michigan, it is also expected to emerge.

These remarkable insects, which are the longest-lived of all the six-legged hordes that crawl the earth, spend over sixteen years under ground, clinging to plant roots from which they suck their nourishment. Then, in the spring of the seventeenth year, they emerge from their burrows, shed their pupa cases, and spend a few weeks as fully developed adults, mating and depositing eggs to provide for the next generation.

During the four or five weeks of their above-ground existence the seventeen-year cicadas make their presence known by the incessant shrill song of the males. The chorus of millions of tiny saw-like voices is very disagreeable to many persons. The Pilgrim Fathers didn't like it. Governor Bradford spoke of it as "a constante yelling noyes, as made all ye woods ring of them and ready to deafe ye hearers."

The immense number of these rather large insects sometimes causes alarm, but they are really comparatively harmless. They feed very seldom or not at all, depending on the reserves accumulated during their long underground life. The principal mischief is caused when the females lay their eggs, which they deposit in furrows cut into the green bark of young twigs. This causes a temporary defoliation of many trees, but no permanent harm in the forests. It may be very damaging at times, however, in orchards and nurseries.

There are 17 "broods" of the seventeen-year cicada, distributed in various parts of the country. One brood comes out each year. The one emerging this year is designated as Brood II. Brood III, which is due in 1929, has its headquarters in the prairie states, especially Iowa, In addition to the seventeen-year species there is an allied thirteen-year form which ranges principally in the lower Mississippi region. This is divided into 13 broods, so that an outbreak of this insect also is to be expected somewhere in the South every year.

ITEMS

ACCORDING to Dr. M. Blaschke, a German ceramic chemist, glass windows were in use in ancient Rome. Most of the panes did not exceed 12 by 16 inches in size, though a few larger ones have been found. Glass-making, known for many centuries in Egypt, came to Rome relatively late. During the time of Cicero, who died in 43 B. C., glass objects of any kind were rarities, and glass windows were unknown. A hundred years later most households owned some, and by the time the Empire was well established glass was fairly common. The famous mosaics of the later Empire, notably at Ravenna and Constantinople, were made largely out of bits of glass.

A 120,000-pound master truck scale of the plate-fulcrum type, used for weighing railroad trucks, was this month installed and housed on the Chicago Belt line in Chicago by the United States Bureau of Standards. Since the scale has a sensitivity to one tenth of a pound and so is accurate to the millionth point under full load, the bureau believes that it will do much for standardization in heavy weighing. The scale is so sensitive that the atmospheric barometric pressure causes different registrations of weight for one object. It is the purpose of the bureau to have different railroads bring their different type cars to this scale, have them weighed, and then send these cars back to the scales of the railroad for a checkup of differences. In this way, a standard weight can be established and maintained from coast to coast for the first time.

APPARENT "earthquakes" accompanying a great meteor, such as that which flashed over Georgia and South Carolina recently, are really due to air waves from the speeding celestial projectile. This is the opinion of Professor Charles P. Oliver, of the University of Virginia and recognized authority on meteoric astronomy. It is not possible for such a meteor to cause an actual tremor of the earth, he stated. However, as it passes through the earth's atmosphere, it causes air waves, similar to those caused by a projectile from a large gun. The meteor may travel as fast as 25 miles a second, or around fifty times the speed of the shell from the gun, and so the air waves are much stronger. As they strike houses and buildings, they cause them to vibrate, even breaking window panes and cracking plaster walls. To a person within such a building, the effects are practically indistinguishable from those of an earthquake.